Characterization of 2010 Base Flow and Pulse Flow Water Quality in the Jackson River

Water Quality Monitoring, Biological Monitoring and Water Quality Assessment Programs

Department of Environmental Quality

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Executive Summary

It is well documented from Virginia Department of Environmental Quality's (VDEQ) monitoring and assessment data (VDEQ 1996, VDEQ 2002, VDEQ 2004) and Jackson River benthic Total Maximum Daily Load (TMDL) development (VDEQ 2010) that low flow conditions in the fall represent the most stressed water quality conditions in the Jackson River. To assess flow variability impacts on water quality habitat and biology, VDEQ asked the U.S. Army Corps of Engineers (ACE) to perform a 216 study that could result in permanent flow modifications in the Jackson River. As part of the study, the ACE performed a test pulse on August 17th, 2010. A storm event was mimicked for eight hours with flows reaching 3000 cubic feet per second (cfs) for two hours. This report details the data collection results that VDEQ performed throughout the year with emphasis on data collection before, during and after the pulse event.

The Jackson River benthic TMDL study established nutrient and phosphorous reduction targets in the Jackson River and called for restoring natural flow variability to the Jackson River during the growing season defined in the TMDL study as June 1st to October 31st. A 216 study is required to make any water control plan modifications to a federally operated dam. During the 216 study period, the data collection emphasis is on documenting pre-hydrologic modification baseline conditions. VDEQ collected an extensive suite of field, chemistry, habitat, and biological parameters to document current conditions.

This year's report and the 2012 report will simply document current conditions, while future monitoring reports will focus on documenting any positive or negative impacts associated with changing flows in the Jackson River. Preliminary observations:

- Temperature, Dissolved Oxygen, pH, and Specific Conductivity in the Jackson River were not negatively impacted in stream from pulse event. Dissolved oxygen was improved significantly below Covington.
- Thermocline in lake remained intact during summer pulse event
- Metals were low from pulse event and within all water quality standards
- Total suspended solids and turbidity increased significantly during pulse event in the entire reach. VDEQ suspects multiple pulse events over the entire growing season would result in more moderate solids levels (due to lack of buildup from tributaries)
- Habitat in the Jackson River is in optimal conditions with few sedimentation issues. Slight habitat improvements were documented for in-stream embeddedness, an important parameter for improving aquatic life in the Jackson River below Covington.
- Documented current fish and macroinvertebrate community structure to ensure above Covington tailwater maintains high biotic integrity and we can document improved biotic integrity below Covington

Introduction

It is well documented from Virginia Department of Environmental Quality's monitoring and assessment data (VDEQ 1996, VDEQ 2002, VDEQ 2004) and Jackson River benthic TMDL development (VDEQ 2010) that low flow conditions in the fall represent the most stressed water quality conditions in the Jackson River. The Jackson River benthic TMDL study established nutrient and phosphorous reduction targets in the Jackson River and called for restoring natural flow variability to the Jackson River during the growing season defined in the TMDL study as June 1st to October 31st. The nutrient reductions and flow variability will result in improved benthic habitat and water chemistry in the Jackson River, which will result in improved aquatic life allowing VDEQ to delist the Jackson River from the 303(d) list. In order to assess flow variability impacts on water quality habitat and biology, VDEQ asked the U.S. Army Corps of Engineers (ACE) to perform a 216 study that could result in permanent flow modifications in the Jackson River. As part of the study, the ACE performed a test pulse on August 17th, 2010. A storm event was mimicked for eight hours with flows reaching 3000 cubic feet per second (cfs) for two hours at Gathright Dam.

VDEQ established a special study to document current water quality, habitat, and biological conditions in the Jackson River from Gathright Dam to the head of the James River. This monitoring plan is detailed in a Quality Assurance Project Plan for the Special Study of Jackson River Watershed (VDEQ 2009). Station locations and data collection activities that VDEQ performed throughout the year are found in Tables 1 and 2. A map of the station locations is found in Figure 1. Data collection activities related to before, during and after the pulse event are found in Tables 3, 4, 5 and 6.

Table 1. Monitoring Station ID with location description.

Station ID	Location Description
2-JKS044.10	Jackson River below Gathright Dam at gage
2-JKS030.65	Jackson River at Rt. 687 Bridge – Clearwater Park
2-JKS023.61	Jackson River at City Park – Covington at gage
2-JKS018.68	Jackson River at Rt. 18 Bridge at Covington
2-JKS013.29	Jackson River off Rt. 696 above Low Moor
2-JKS006.67	Jackson River at low water bridge near Dabney Lancaster Community College

Table 2. Station ID with monitoring activities throughout the year.

Station ID	Fish Community Data (Annual)	Benthic Algae (Semi-Annual)	Macroinvertebrate Biomonitoring (Annual)	Dissolved Metals (Semi-Annual)	Solids (Bi-Monthly)	Nutrients (Bi-Monthly)
2-JKS044.10		X		X	X	X
2-JKS030.65	X	X	X	X	X	X
2-JKS023.61	X	X	X	X	X	X
2-JKS018.68	X	X	X	X	X	X
2-JKS013.29		X	X	X	X	X
2-JKS006.67	X	X	X	X	X	X

Figure 1. Map of Monitoring station locations

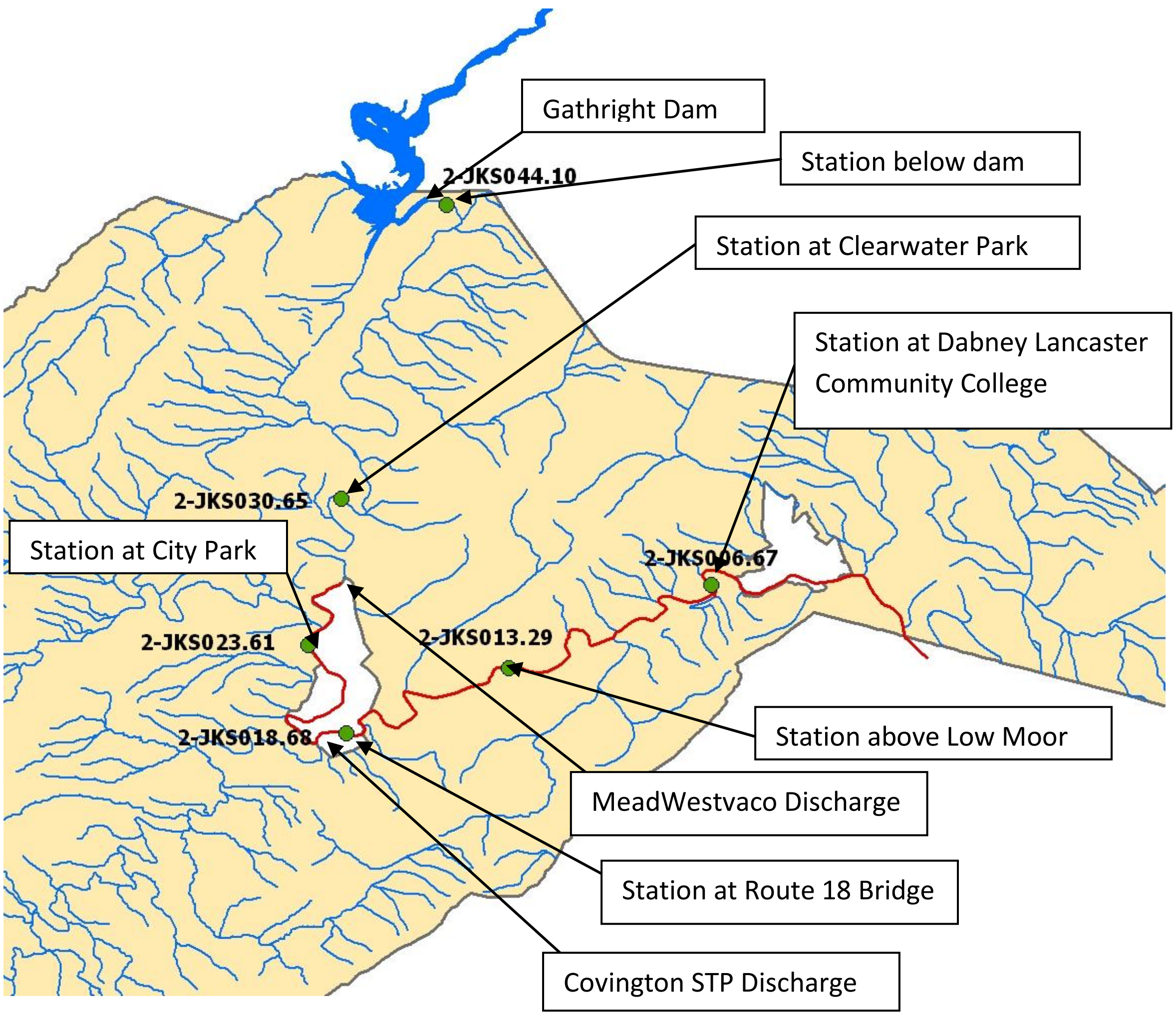


Table 3. Datat collection activities on Monday August 16th (day before the pulse).

Station IDs	Data Collection Activity
2-JKS030.65, 2-JKS023.61	Deployed water quality sondes to collect field data (Dissolved Oxygen, pH, Temperature, and Specific Conductivity) for 3 days
2-JKS026.01, 2-JKS023.61, 2-JKS018.68, 2-JKS013.29, 2-JKS006.67	Collecedt Benthic Chlorophyll A and Ash Free Dry Mass to document pre-pulse conditions
2-JKS044.10, 2-JKS030.65, 2-JKS023.61, 2-JKS018.68, 2-JKS013.29, 2-JKS006.67	Collected Dissolved Metals to document pre-pulse metal levels
2-JKS044.10, 2-JKS030.65, 2-JKS023.61, 2-JKS018.68, 2-JKS013.29, 2-JKS006.67	Performed RBP Habitat Survey
ACE stations in Lake Moomaw	ACE monitoring team collected dissolved oxygen and temperature profile data

Table 4. Data collection activities on Tuesday August 17th (day of pulse).

Station IDs	Data Collection Activity
2-JKS044.10, 2-JKS030.65, 2-JKS023.61, 2-JKS018.68, 2-JKS013.29, 2-JKS006.67	Collected Dissolved Metals to document metal levels during pulse events
2-JKS044.10, 2-JKS030.65, 2-JKS023.61, 2-JKS018.68, 2-JKS013.29, 2-JKS006.67	Collected water chemistry parameters and field data which includes solids and nutrient parameters to document nutrient and solids conditions during pulse event
ACE stations in Lake Moomaw	ACE monitoring team collected dissolved oxygen and temperature profile data

Table 5. Data collection activities on Wednesday August 18th (day after pulse).

Station IDs	Data Collection Activity
2-JKS030.65, 2-JKS023.61	Pull deployed water quality sondes
2-JKS023.61, 2-JKS018.68, 2-JKS013.29, 2-JKS006.67	Collected Benthic Chlorophyll A and Ash Free Dry Mass to document post-pulse conditions
2-JKS044.10, 2-JKS030.65, 2-JKS023.61, 2-JKS018.68, 2-JKS013.29, 2-JKS006.67	Performed RBP Habitat Survey
ACE stations in Lake Moomaw	ACE monitoring team collected dissolved oxygen and temperature profile data

Table 6. Data collection activities during the week of August 23rd and September 6th (1 week and 3 weeks after pulse).

Station IDs	Data Collection Activity
2-JKS023.61, 2-JKS13.29	Collected Benthic Chlorophyll A and Ash Free Dry Mass to evaluate re-growth rates

Water Chemistry Data Results

Field Data

Field data were collected using an YSI muliprobe sonde. Temperature, pH, and dissolved oxygen appeared normal and followed expected seasonal patterns. Specific conductivity readings in the Jackson River during the low flow months are above the normal ranges seen in Virginia. Normal ranges in Virginia are typically below 400 uS/cm.

Figure 2. Temperature (^{o}C) 2010

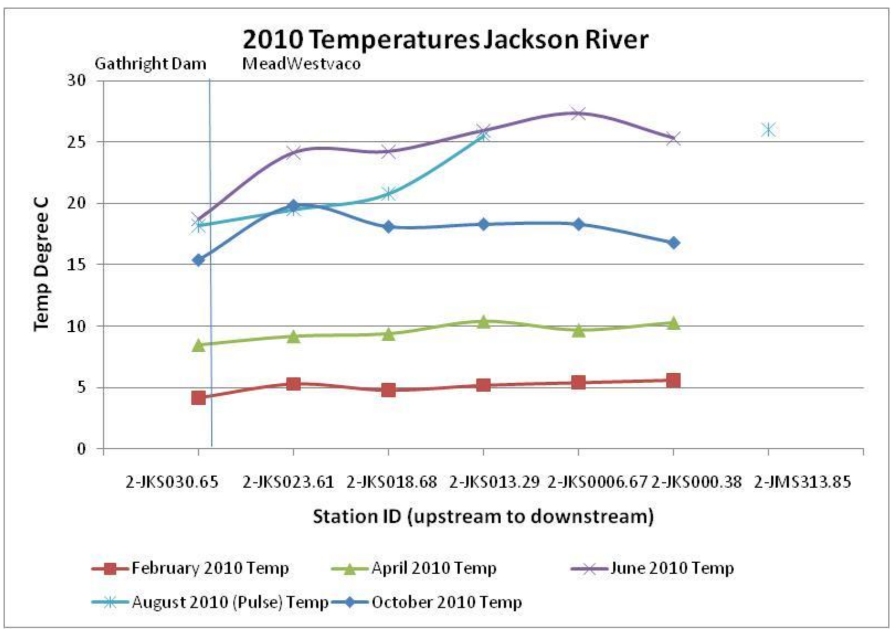


Figure 3. pH 2010.

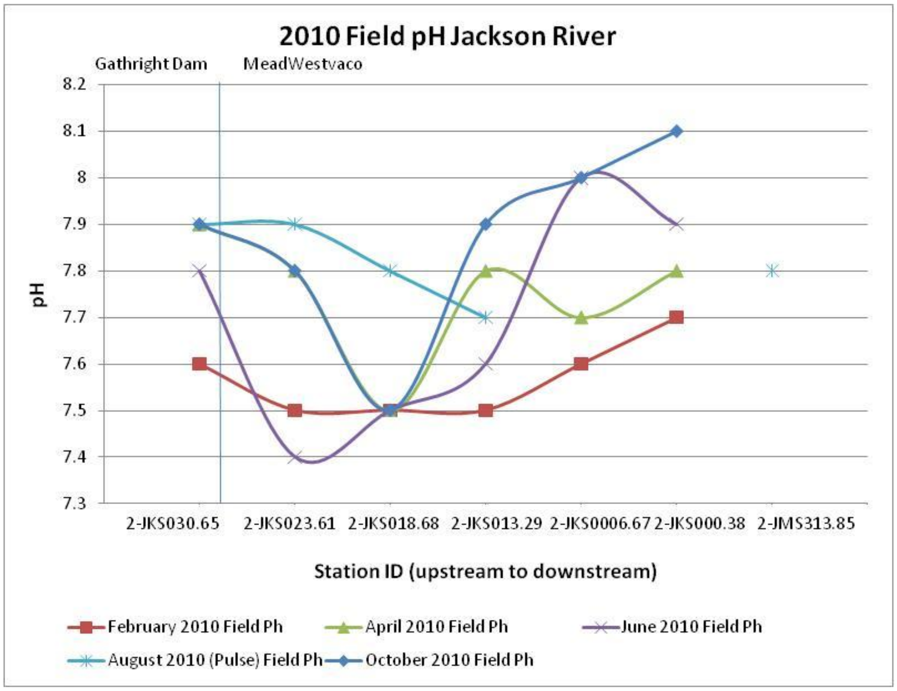


Figure 4. Dissolved oxygen (mg/L) 2010.

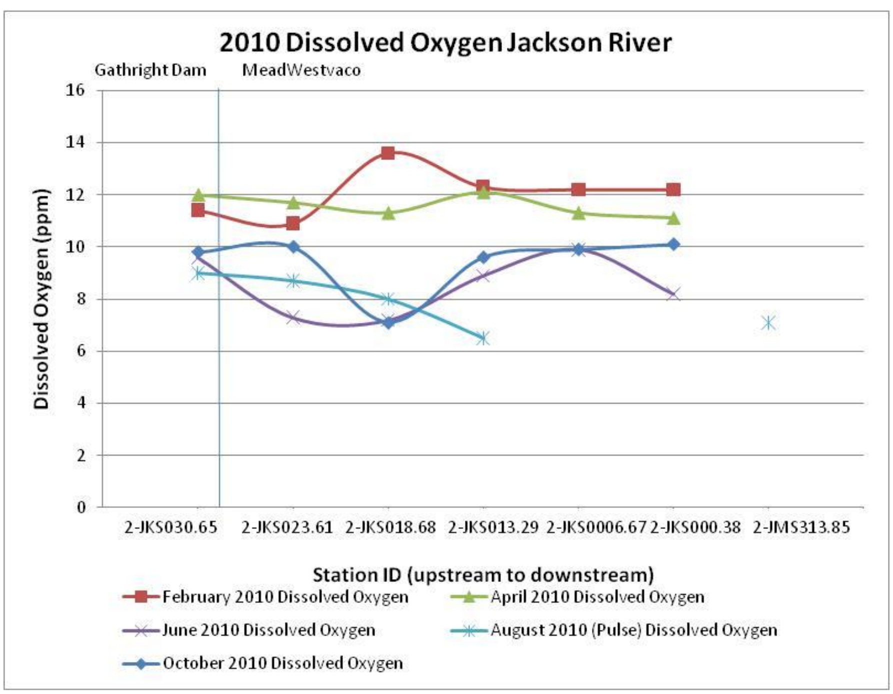
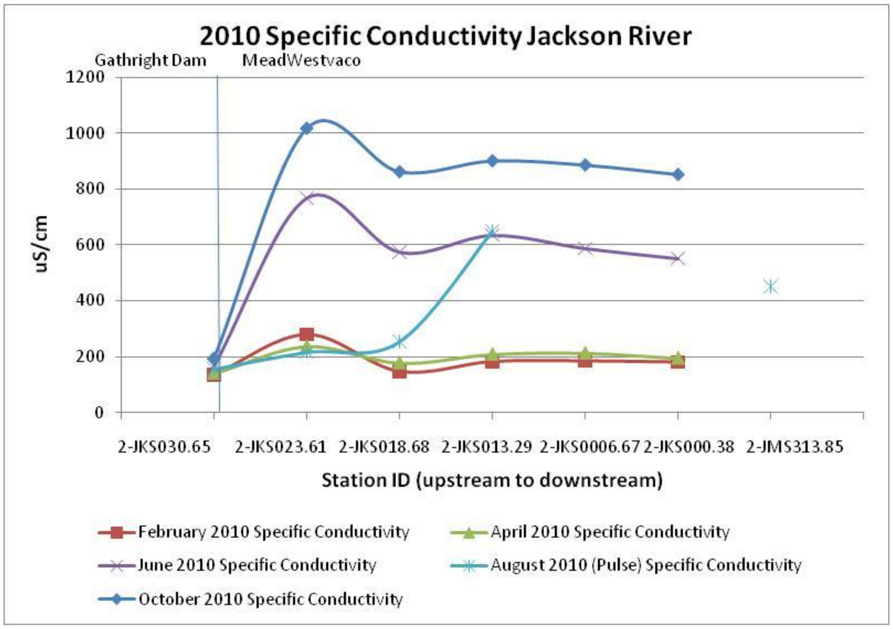


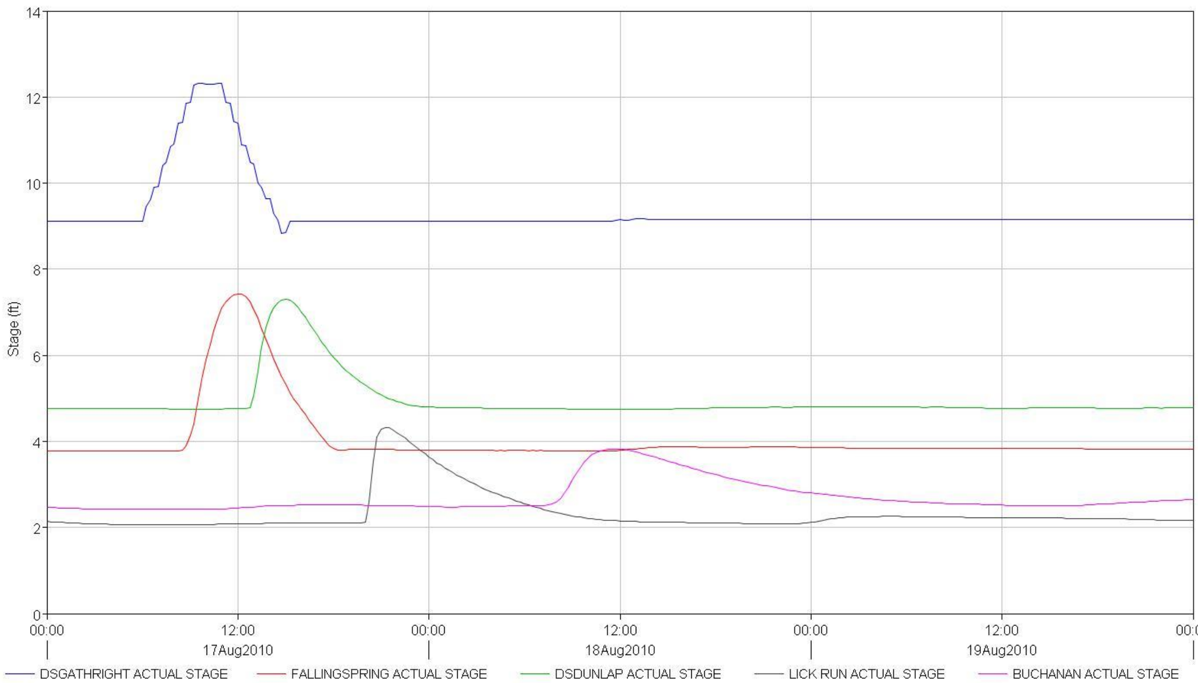
Figure 5. Specific conductivity (uS/cm) 2010.



Real-Time Flow and Field Data

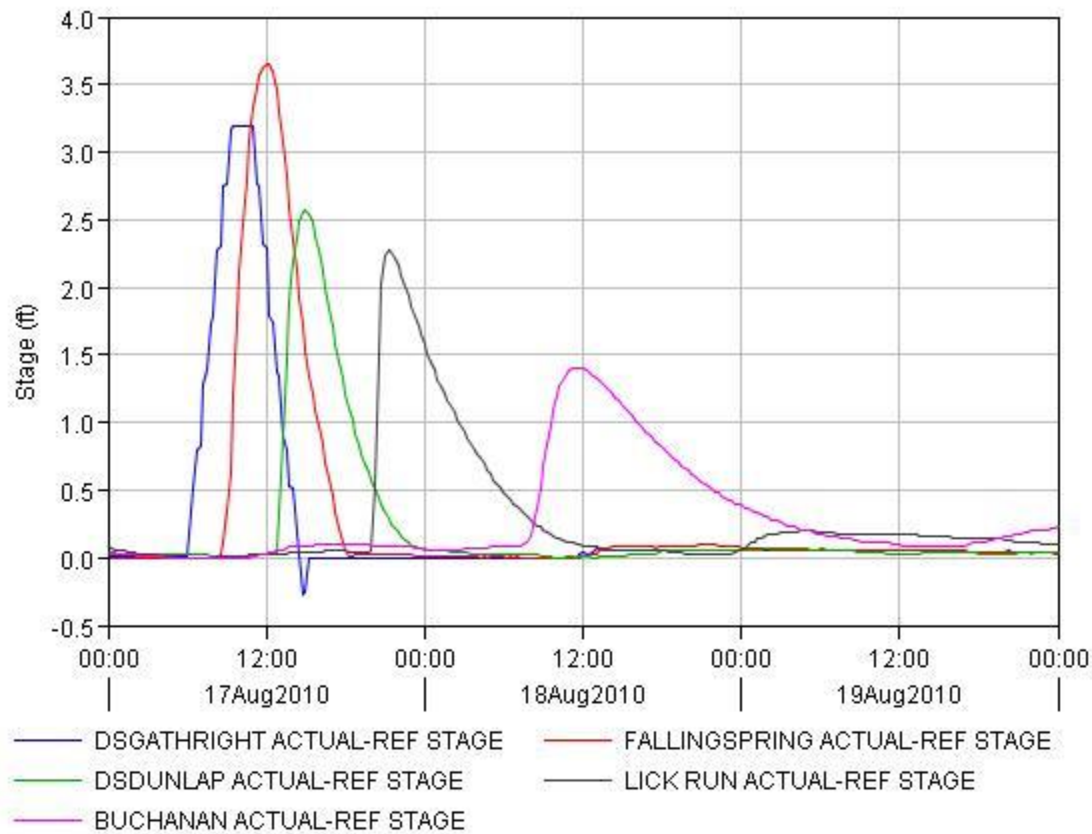
Temperature, pH, dissolved oxygen, and specific conductivity readings were taken every 15 minutes at Clearwater Park and City Park from August 16th, 2010 to August 18th, 2010 using YSI field data sondes. The time period that indicated peak pulse flow influence is illustrated on every graph. The hydrograph of the pulse (which was intended to mimic a storm event) is seen in Figures 6, 7, 8, and 9. Figure 6 illustrates individual pulse stages, figure 7 displays references pulse stages, figure 8 presents individual pulse flows, and figure 9 shows referenced pulse flows. In general the pulse decreased temperatures, increased oxygen levels, and reduced specific conductivity. pH levels remained stable at Clearwater Park, however the pH probe at City Park failed the QA post check and is not reported.

Figure 6. Pulse stages (from USGS provisional data).



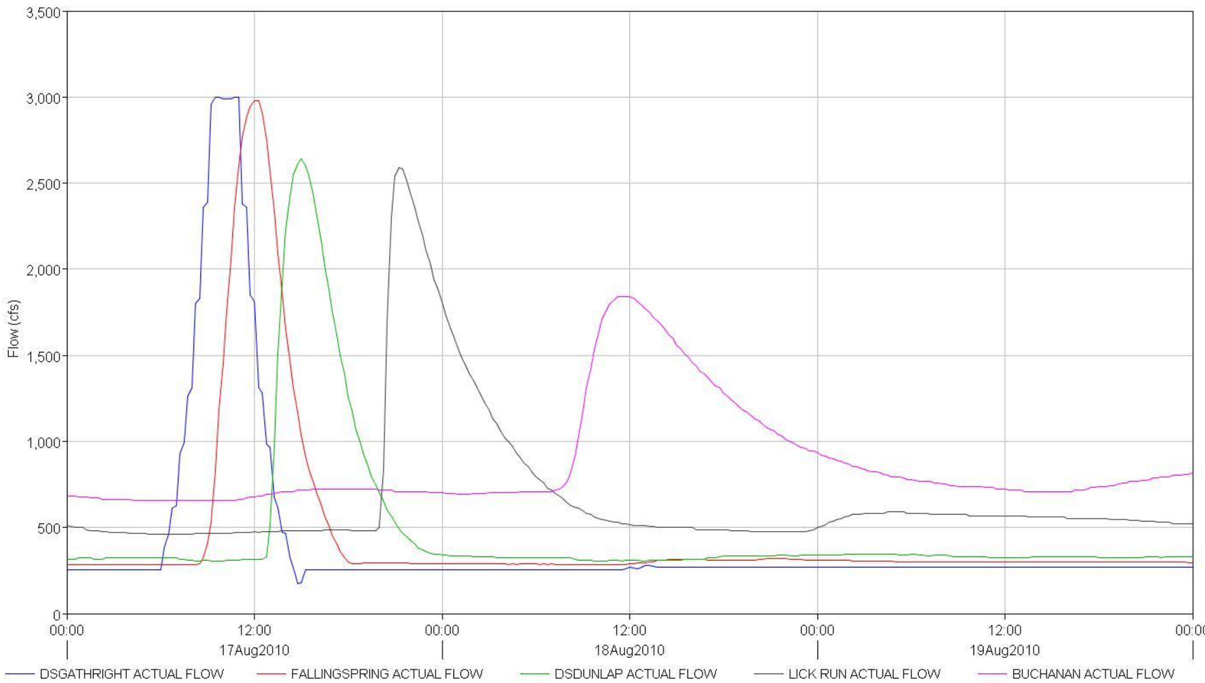
The blue line on the graph illustrates the stage height on the Jackson River at Gathright dam. The red line shows the stage height on the Jackson River at Falling Springs. The green line shows the stage height on the Jackson River at City Park. The brown line depicts the stage height at the James River at Lick Run. The pink line displays the stage height on the James River in Buchanan.

Figure 7 Pulse stages referenced (from USGS provisional data).



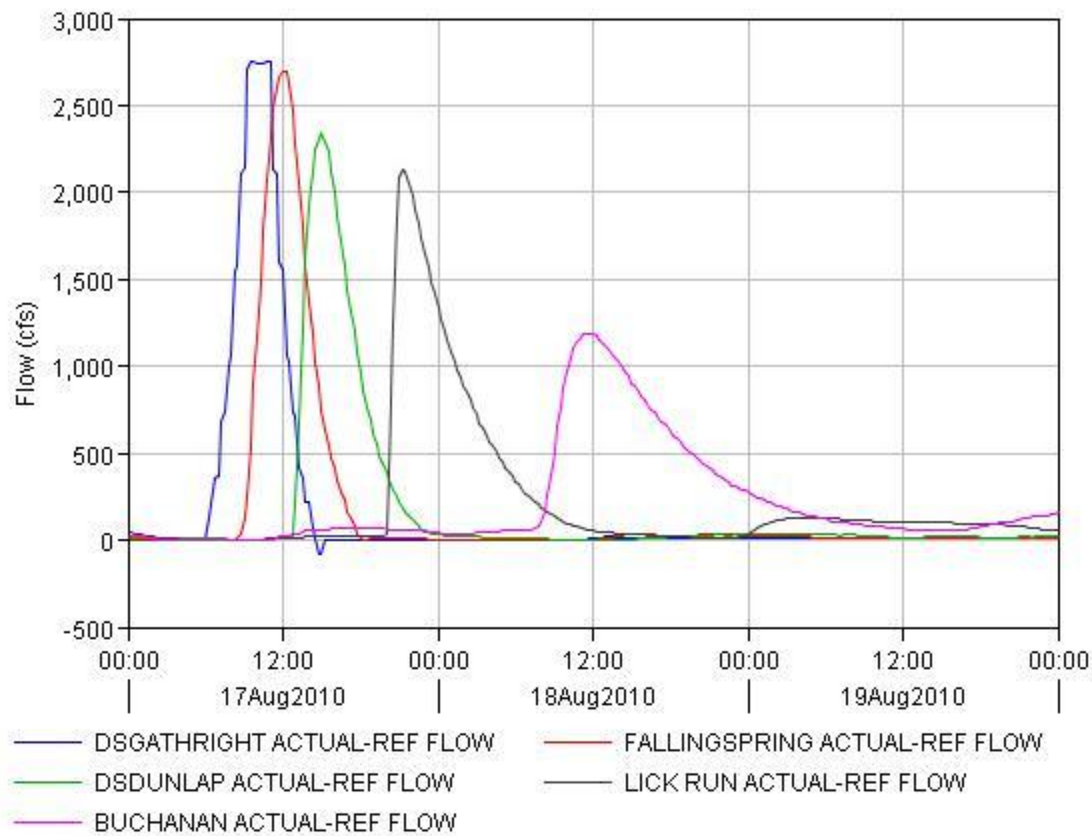
The blue line on the graph illustrates the stage height on the Jackson River at Gathright dam. The red line shows the stage height on the Jackson River at Falling Springs. The green line shows the stage height on the Jackson River at City Park. The brown line depicts the stage height at the James River at Lick Run. The pink line displays the stage height on the James River in Buchanan. This graph has been referenced to show relative differences in stream height that the pulse event had on the Jackson and James River. For example, the Jackson River increased over 3 feet in height below the Gathright Dam, while the James River only increased 1.5 feet in Buchanan.

Figure 8. Pulse flows (from USGS provisional data).



The blue line on the graph illustrates the flow in cubic feet per second (cfs) on the Jackson River at Gathright dam. The red line shows the flow on the Jackson River at Falling Springs. The green line shows the flow on the Jackson River at City Park. The brown line depicts the flow at the James River at Lick Run. The pink line displays the flow on the James River in Buchanan.

Figure 9. Pulse flows referenced (from USGS provisional data).



The blue line on the graph illustrates the flow in cfs on the Jackson River at Gathright dam. The red line shows the flow on the Jackson River at Falling Springs. The green line shows the flow on the Jackson River at City Park. The brown line depicts the flow at the James River at Lick Run. The pink line displays the flow on the James River in Buchanan. The blue line on the graph illustrates the stage height on the Jackson River at Gathright dam. This graph has been referenced to show relative differences in flow that the pulse event had on the Jackson and James River. For example, the Jackson River increased to nearly 3000 cfs below the Gathright Dam, while the James River only increased slightly over 1000 cfs in Buchanan.

Figure 10. Temperature (^{o}C) from Clearwater Park (2-JKS030.65).

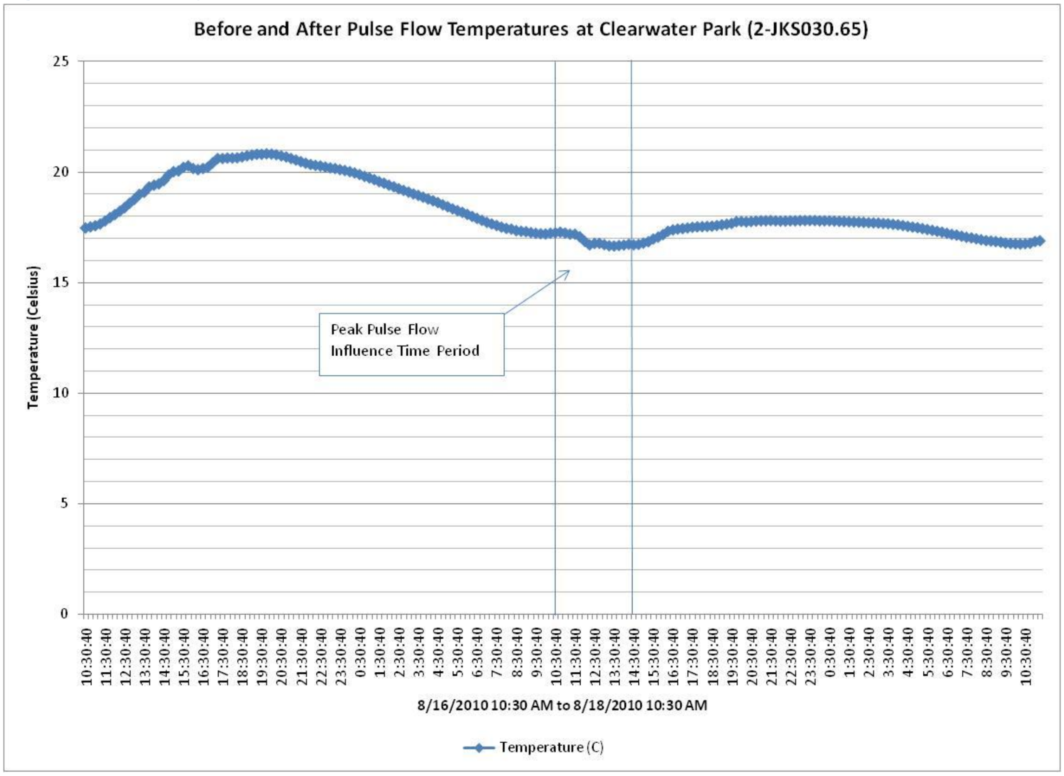


Figure 11. Temperature (^{o}C) from City Park (2-JKS023.61).

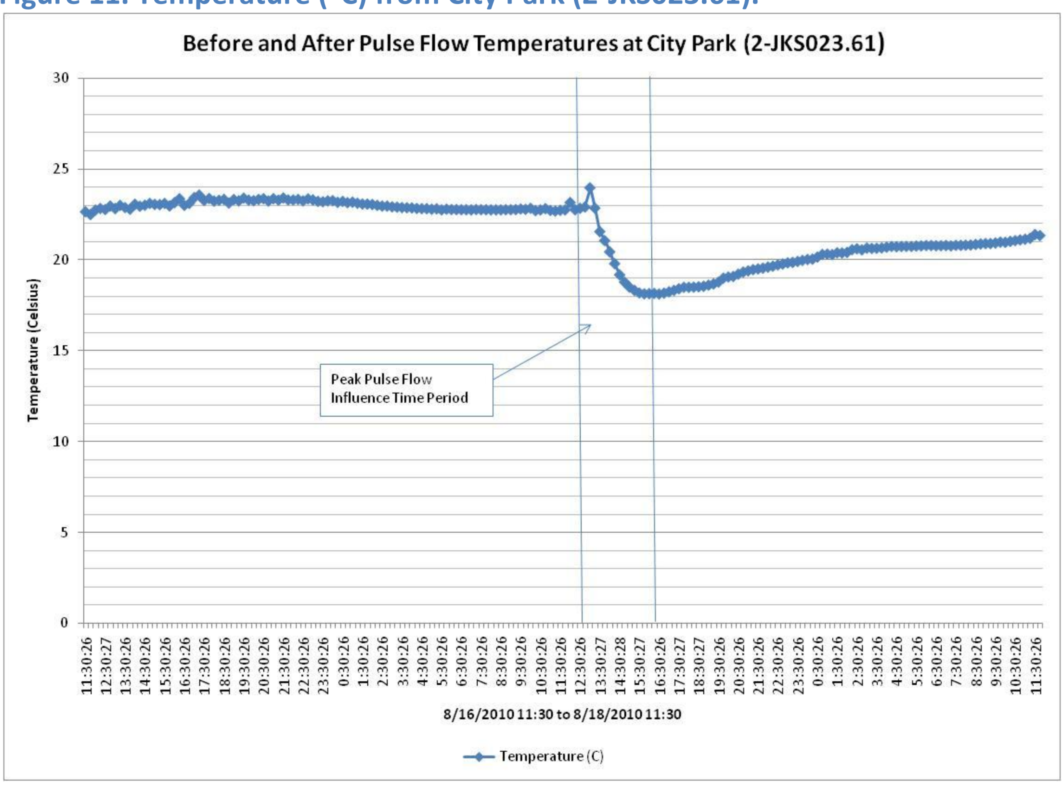


Figure 12. pH from Clearwater Park (2-JKS030.65).

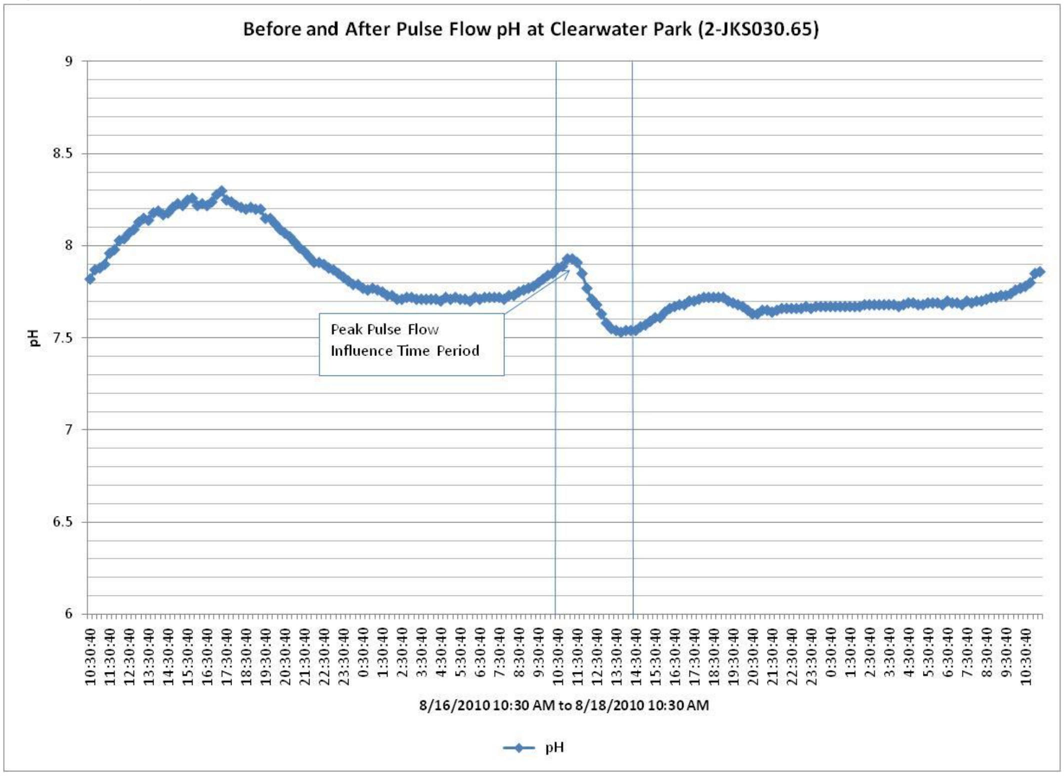


Figure 13. Dissolved Oxygen (mg/L) from Clearwater Park (2-JKS030.65).

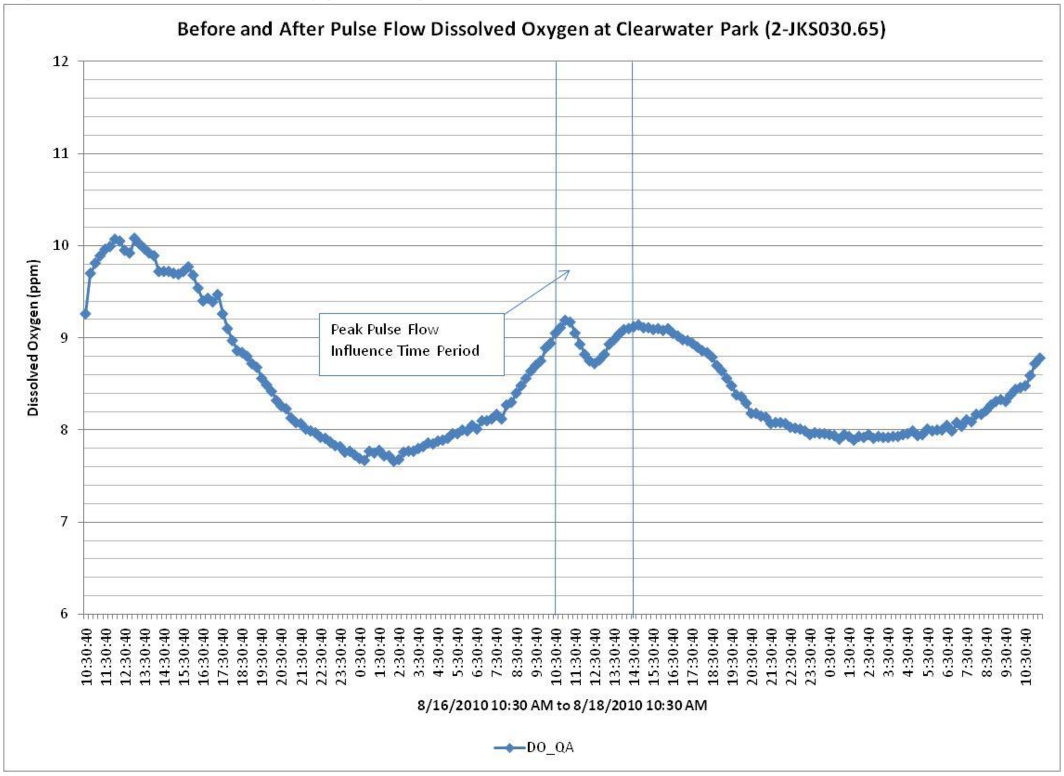


Figure 14. Dissolved Oxygen (mg/L) from City Park (2-JKS023.61).

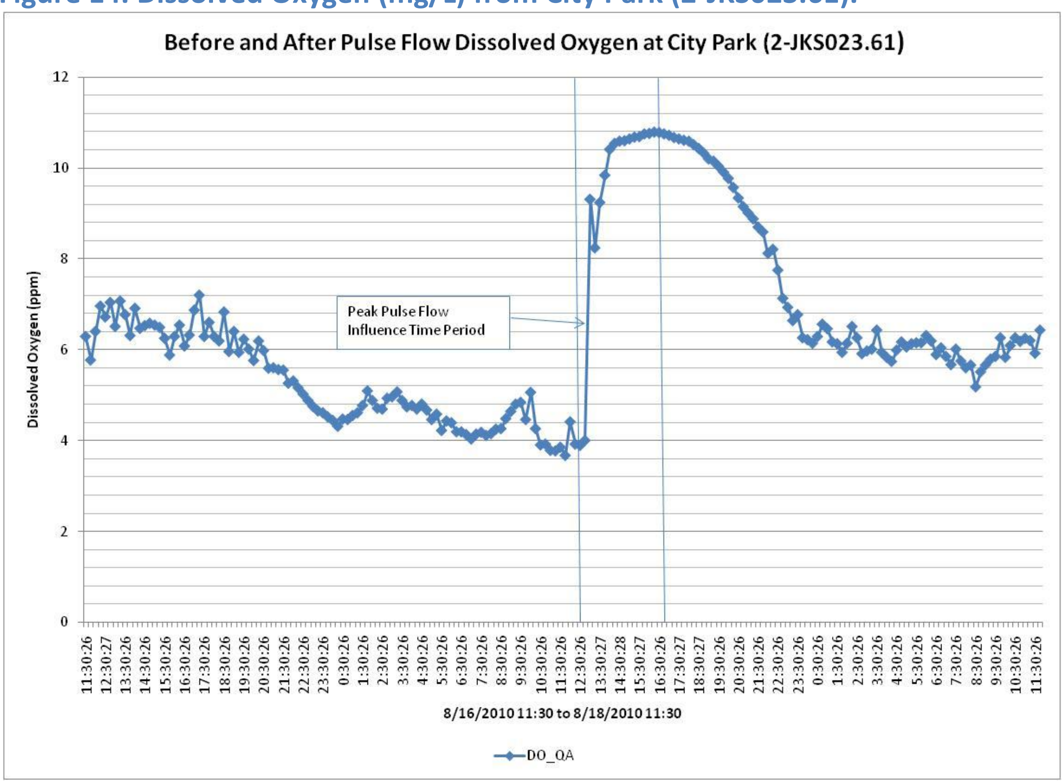


Figure 15. Specific Conductivity (uS/cm) from Clearwater Park (2-JKS030.65).

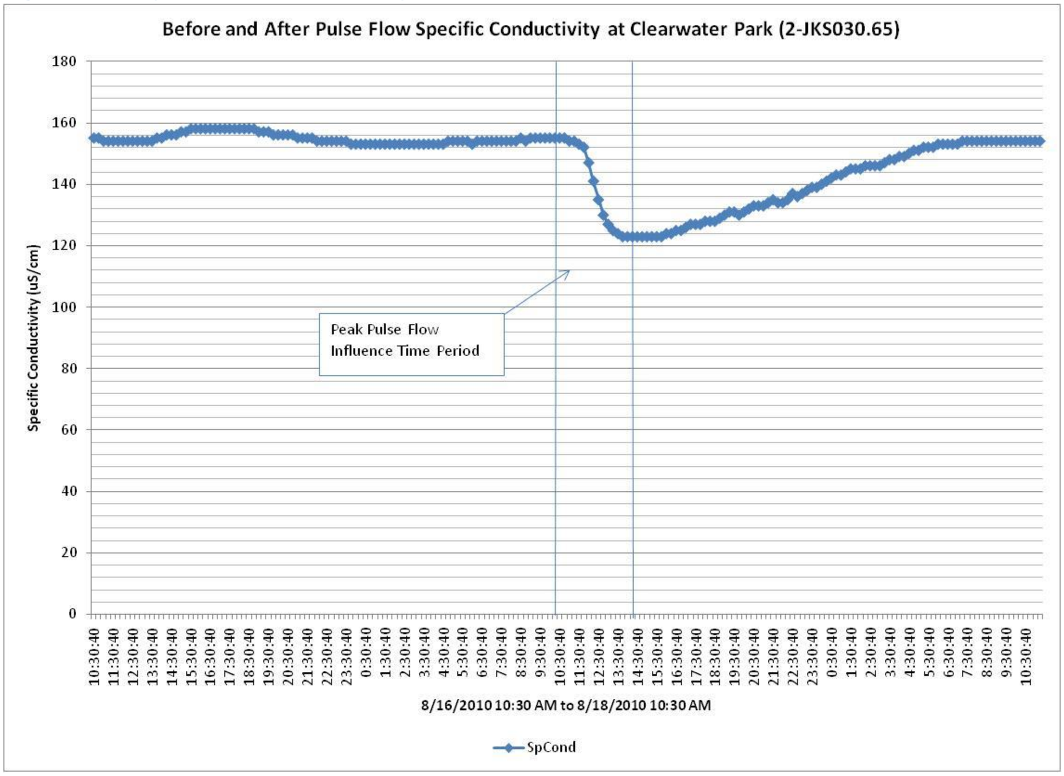
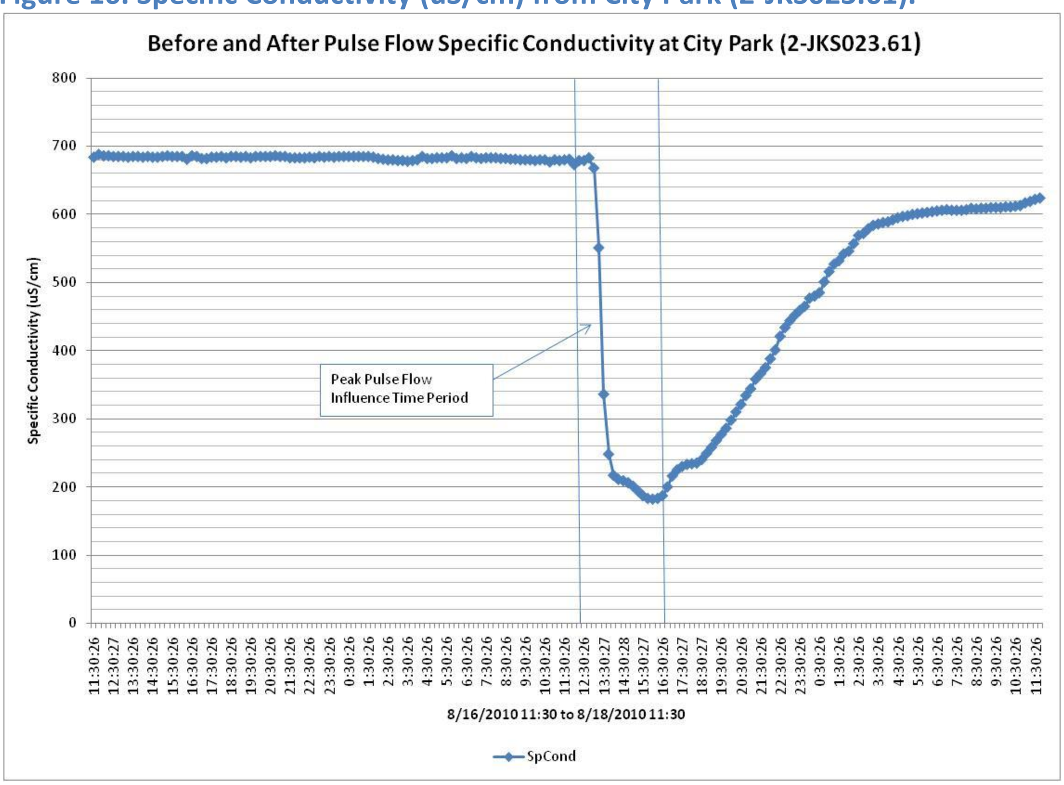


Figure 16. Specific Conductivity (uS/cm) from City Park (2-JKS023.61).



Solids Data

Total solids increase in concentration significantly below the MeadWestvaco discarge. Total suspended solids (TSS) and turbidity measure the amount particles suspended in the water column. In a controlled river system like the Jackson River, the effect of storm pulse flows are muted by the dam, thus increases in TSS and turbidity are not typically observed. The pulse event mimicked a storm event and a significant increase in TSS and turbidity was observed throughout the entire reach except directly below the dam. TSS and turbidity were very low below the dam (see cover photo). Below the dam, very little sediment builds up as no tributaries deposit sediment in the reach. If pulse events were a regular occurrence in the Jackson River, sediment deposition transport from tributaries would be a frequent event. Presumably the TSS and turbidity increases would not be as dramatic as was seen during the August 2010 pulse event when several months of sediment deposition were moved through the river.

Figure 17. Total Solids (mg/L) 2010.

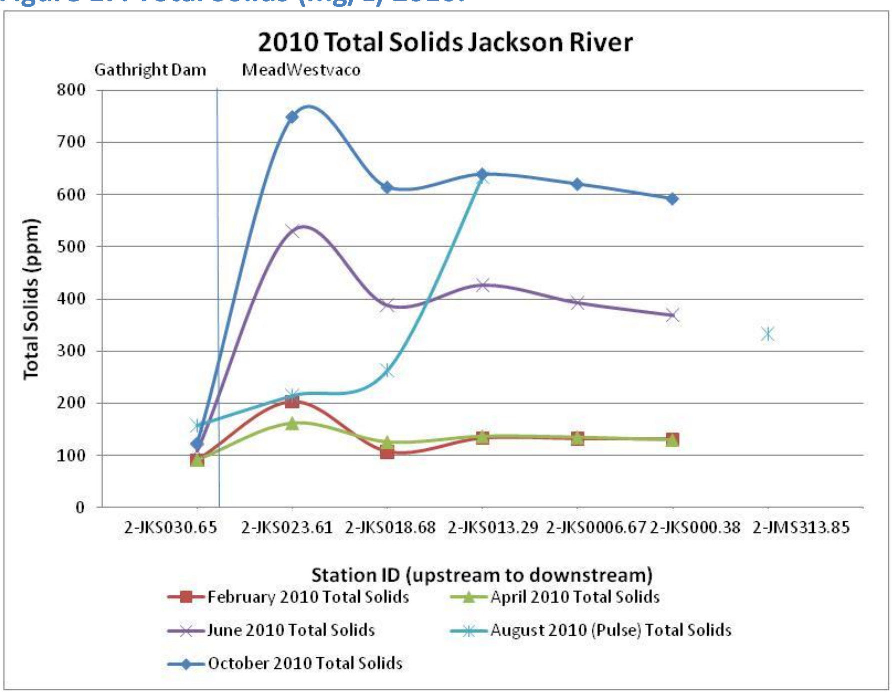


Figure 18. Total Suspended Solids (mg/L) 2010.

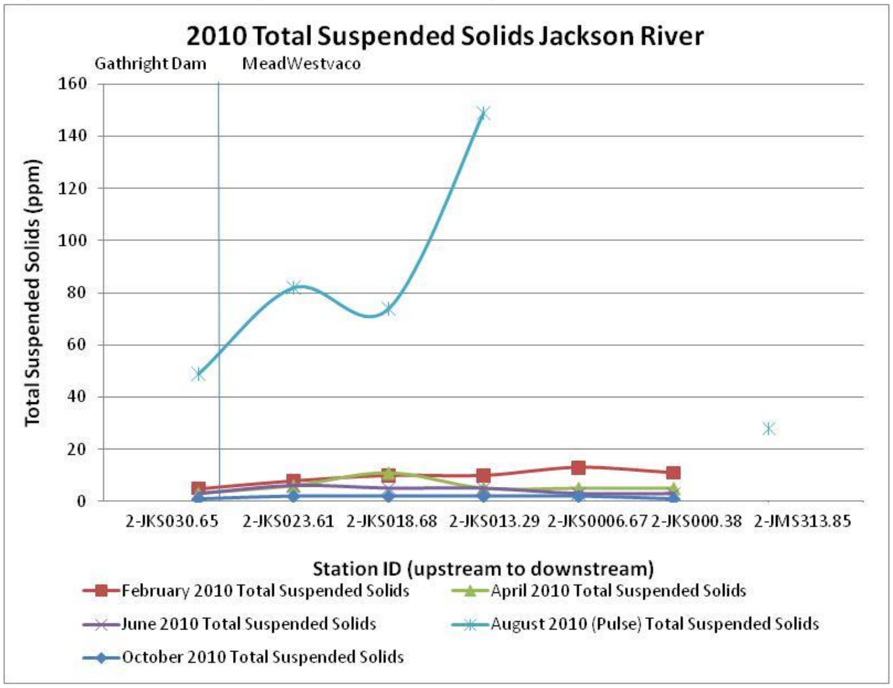


Figure 19. Total Dissolved Solids (mg/L) 2010.

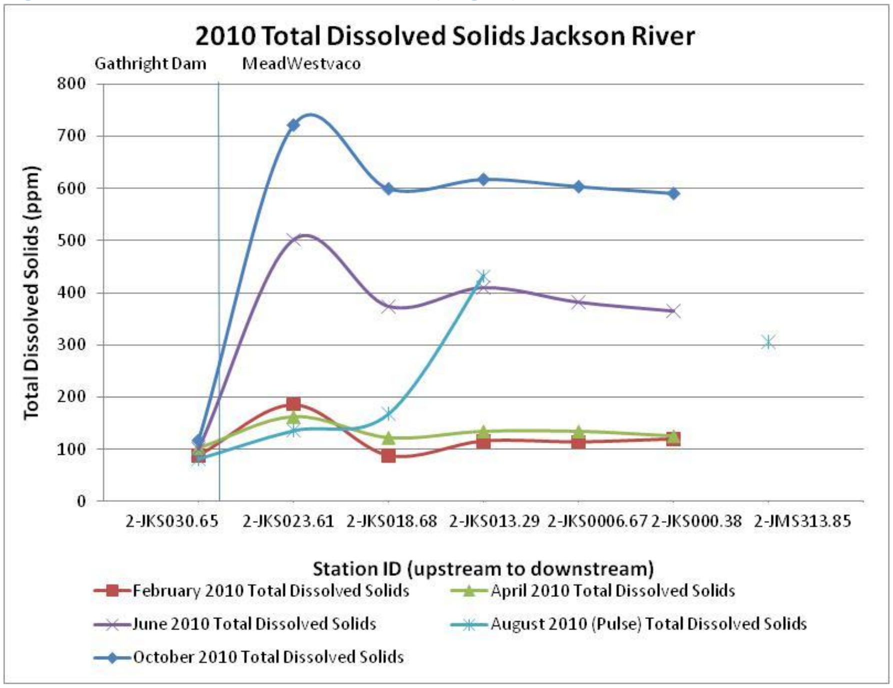
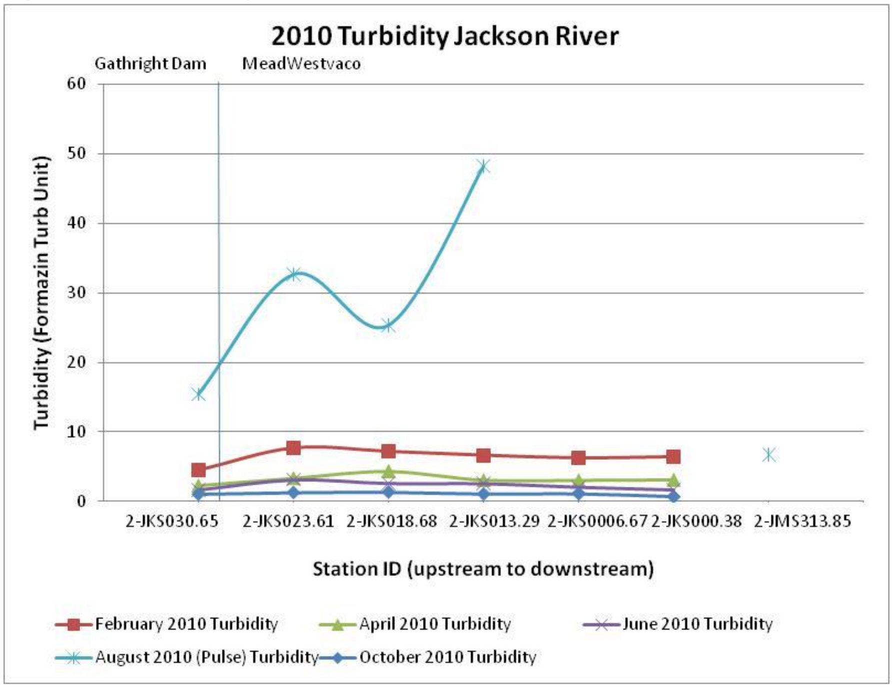


Figure 20. Turbidity (FTU) 2010.



Nutrient Data

The Jackson River Benthic TMDL found excessive nutrient loads are causing increased benthic algal growth. Excessive biomass from nutrient is the most probable stressor to the aquatic community. During the August 2010 pulse event, nutrient concentration increases were observed below the MeadWestvaco Mill discharge and remain elevated downstream to the Route 18 Bridge as the Covington Sewage Treatment Plant enters just above of the bridge (Figure 1). Gradually nutrient levels decrease and benthic algae growth returns to a more normal level and around Dabney Lancaster Community College, aquatic communities improve significantly (see Benthic Macroinvertebrate section – Figure 51).

Figure 21. Total Nitrogen (mg/L) 2010.

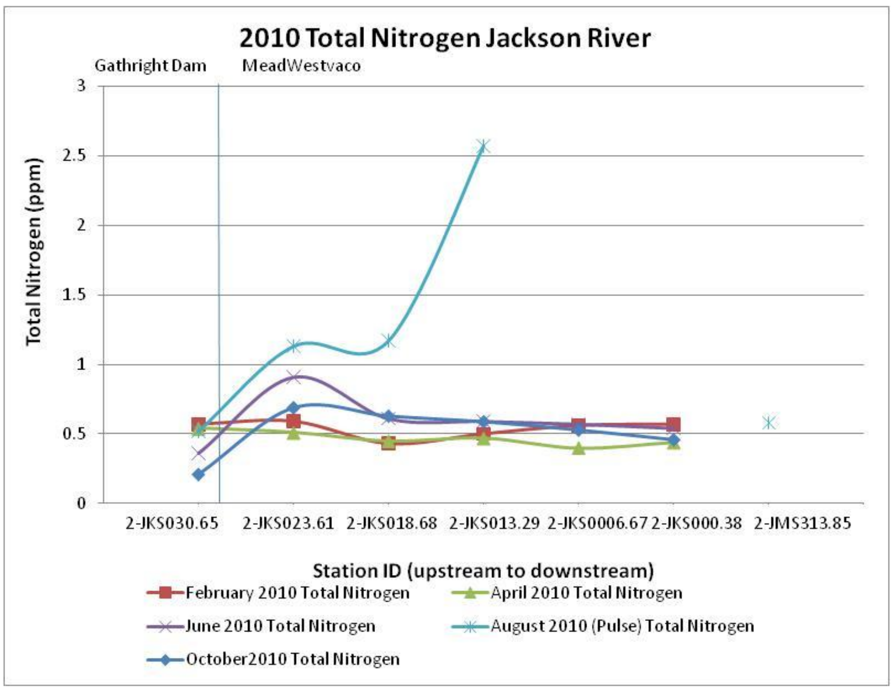


Figure 22. Total Kjeldahl Nitrogen (mg/L) 2010.

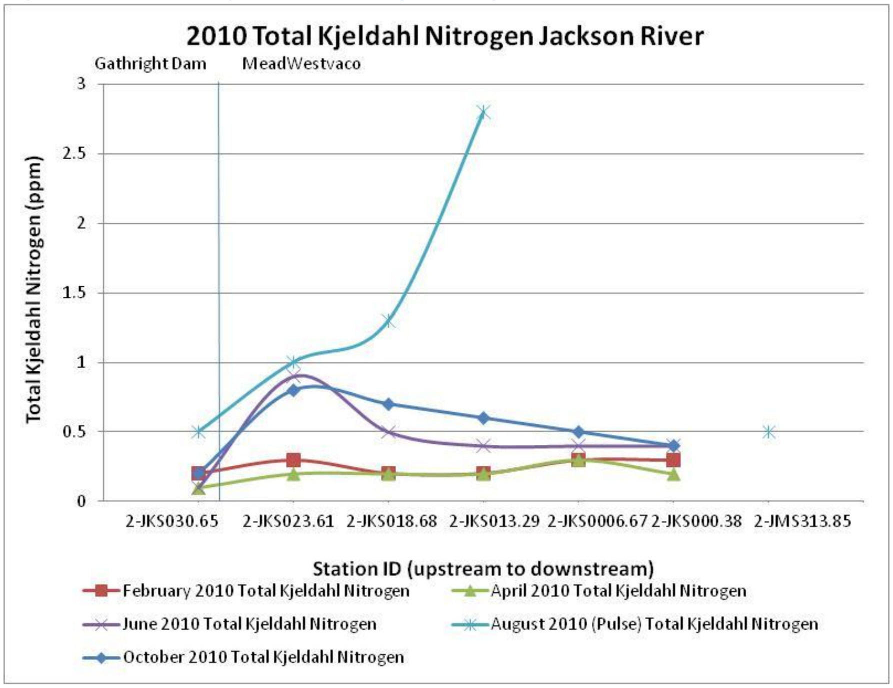


Figure 23. Nitrate-Nitrogen (mg/L) 2010.

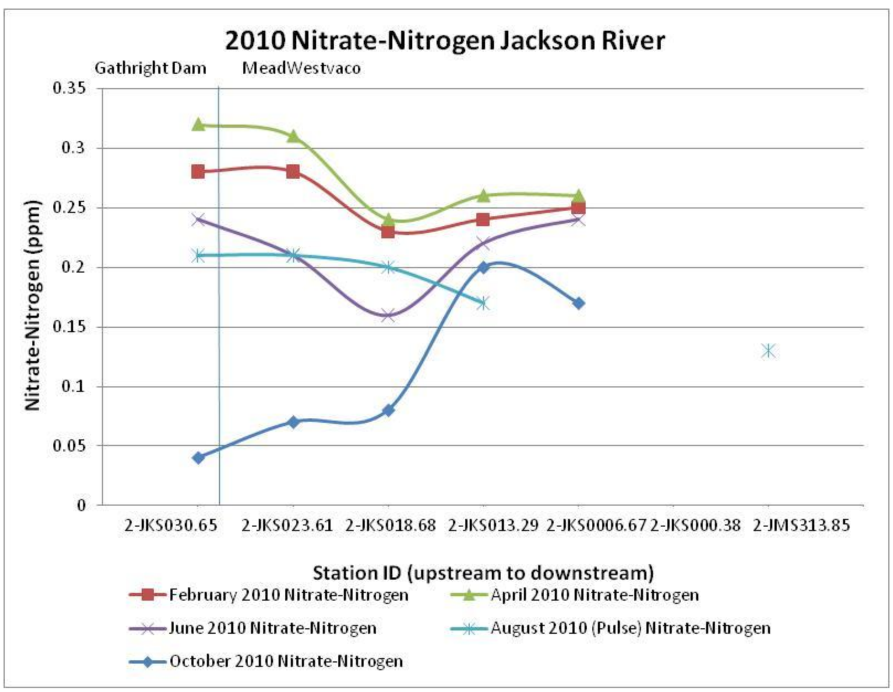


Figure 24. Ammonia (mg/L) 2010.

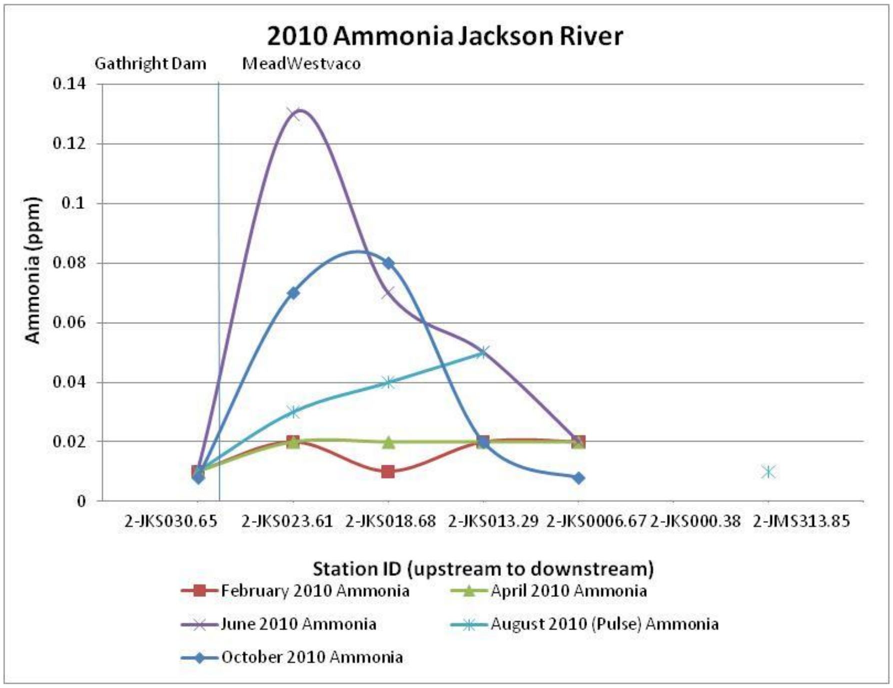


Figure 25. Total Phosphorus (mg/L) 2010.

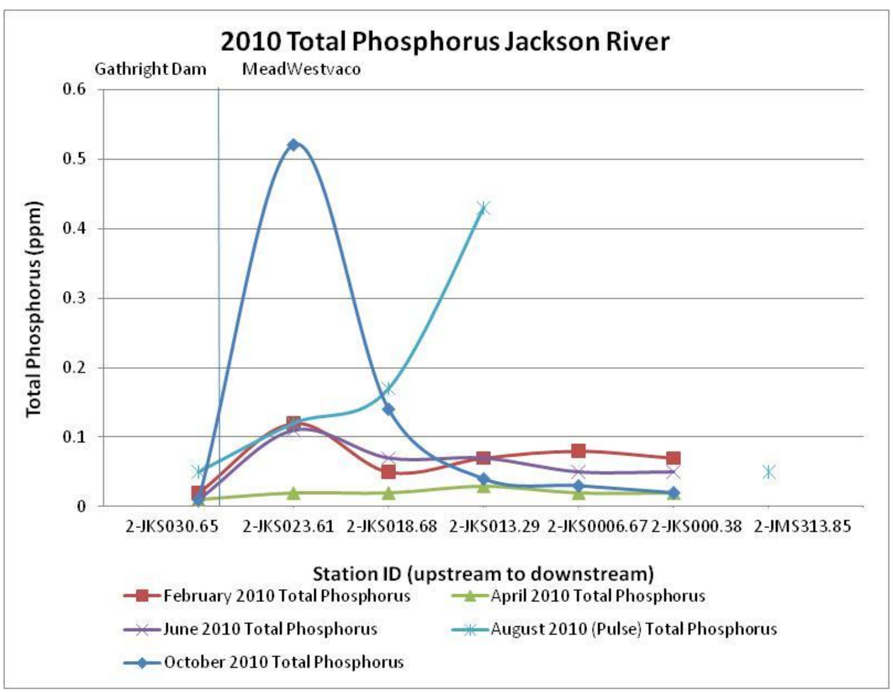
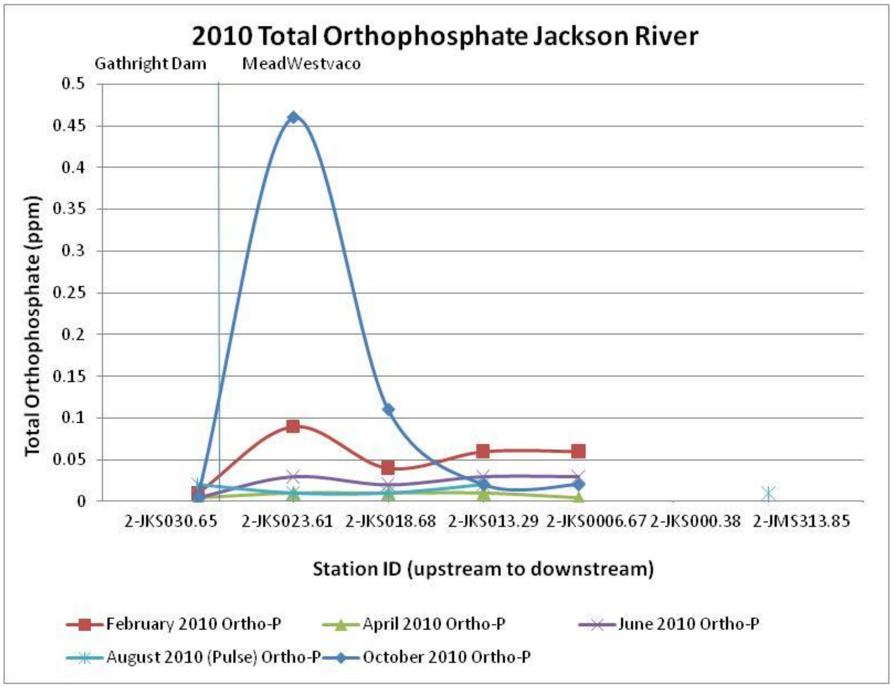


Figure 26. Total Orthophosphate (mg/L) 2010.



Dissolved Metals Data

VDEQ collected an extensive suite of common metals before and during the pulse to ensure that the pulse, which pulled a significant amount of water from hypolimnion, did not cause any exceedences of water quality standards. The metals data are reported as dissolved metals because most water quality standards are based on the biologically available form of metal, which is the dissolved contistuent. The dissolved metals results show that all standards were attained during the pulse event. The only parameter that was found above the 90th percentile was mercury below Covington, which previous monitoring (as late as 2007) had never found. While not a standards violation or caused by the pulse event, the elevated mercury levels may warrant a separate follow-up.

Figure 27. Dissolved Calcium (ug/L).

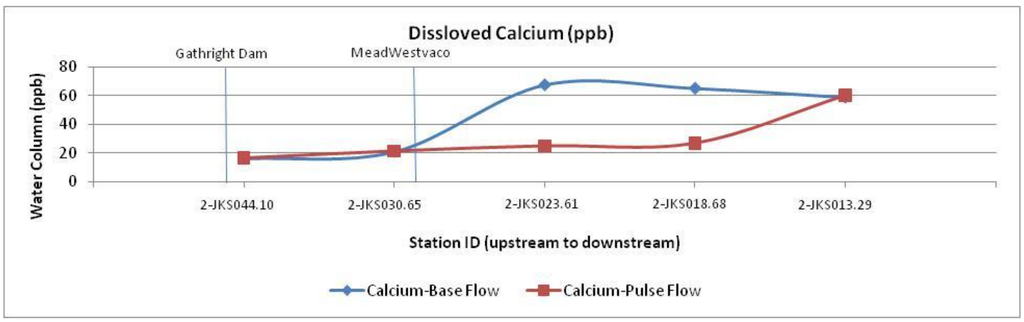


Figure 28. Dissolved Magnesium (ug/L).

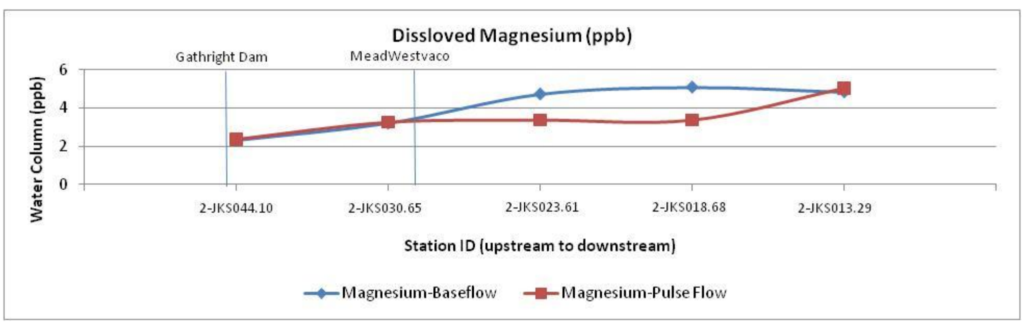


Figure 29. Dissolved Arsenic (ug/L).

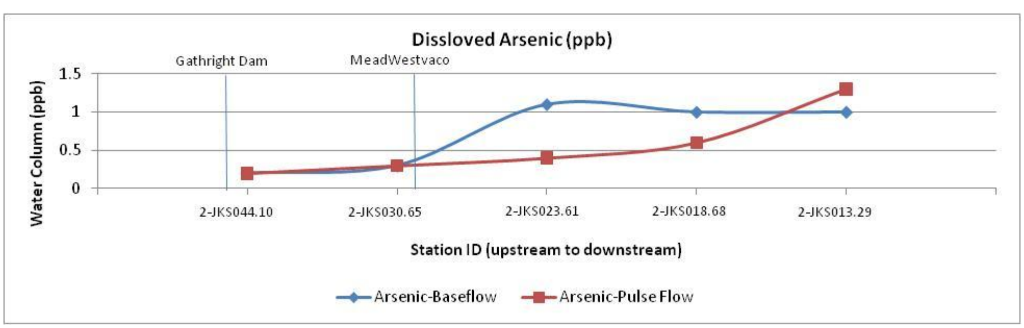


Figure 30. Dissolved Barium (ug/L).

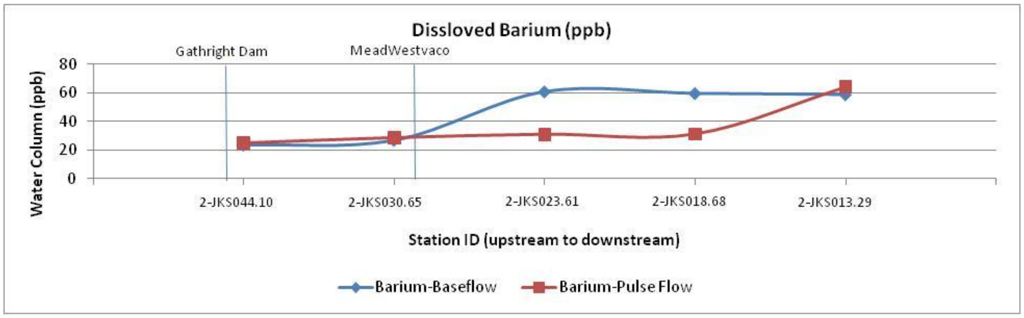


Figure 31. Dissolved Beryllium (ug/L).

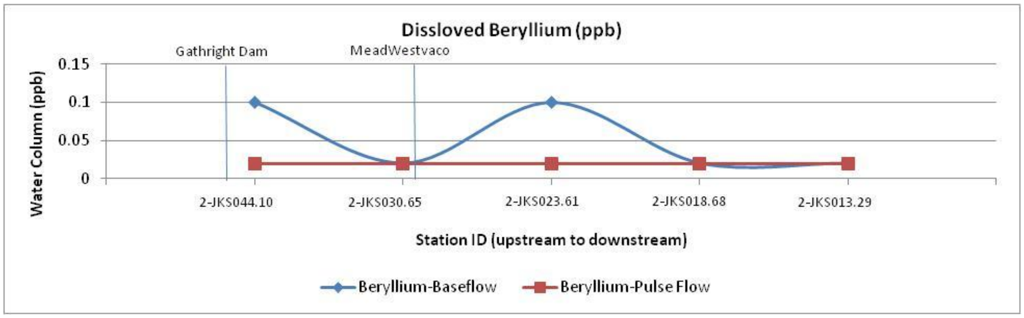


Figure 32. Dissolved Cadmium (ug/L).

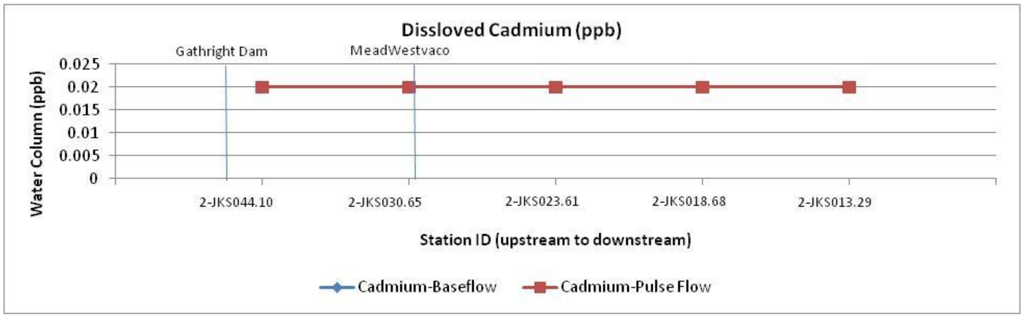


Figure 33. Dissolved Chromium (ug/L).

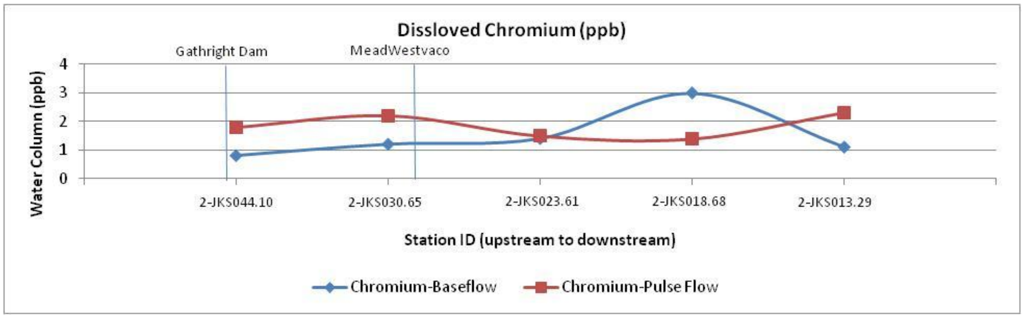


Figure 34. Dissolved Copper (ug/L).

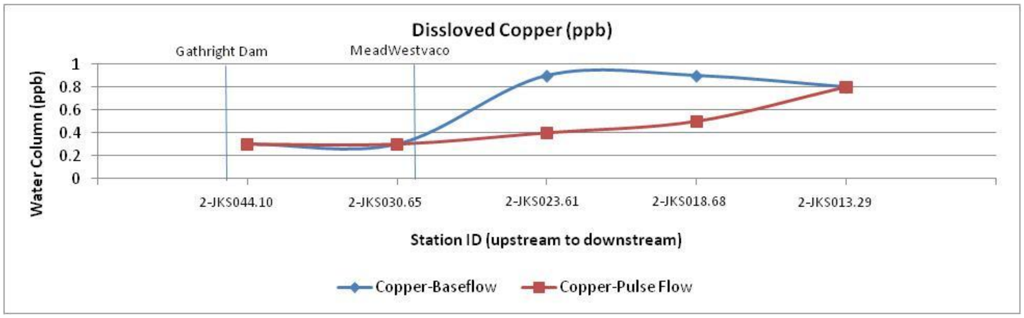


Figure 35. Dissolved Iron (ug/L).

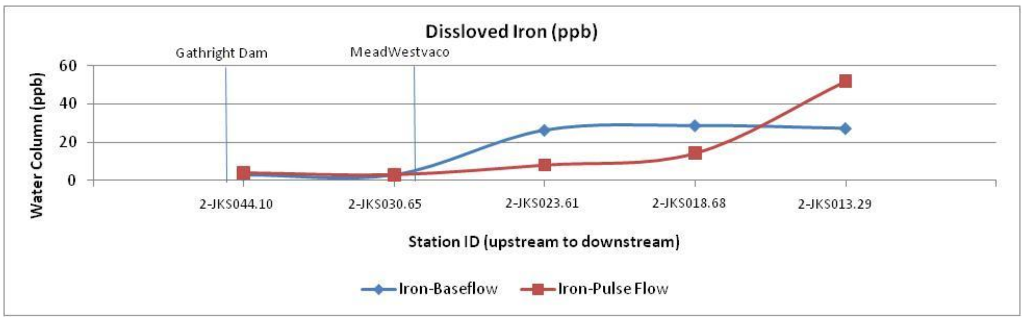


Figure 36. Dissolved Lead (ug/L).

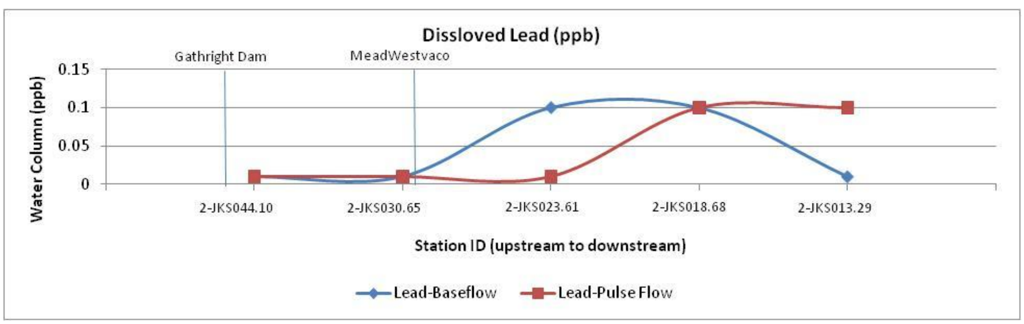


Figure 37. Dissolved Manganese (ug/L).

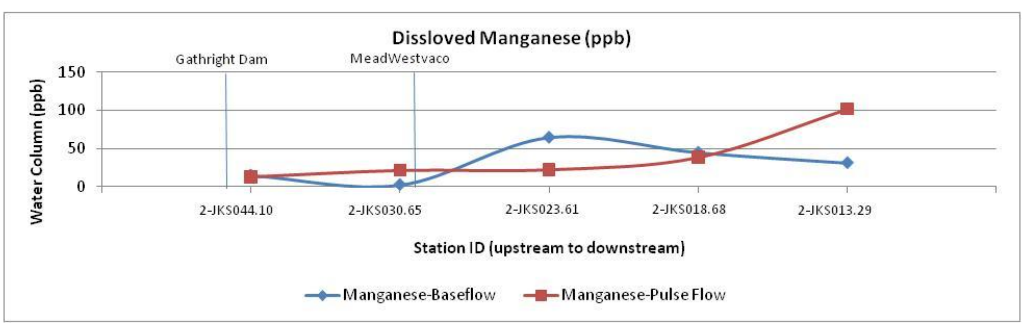


Figure 38. Dissolved Thallium (ug/L).

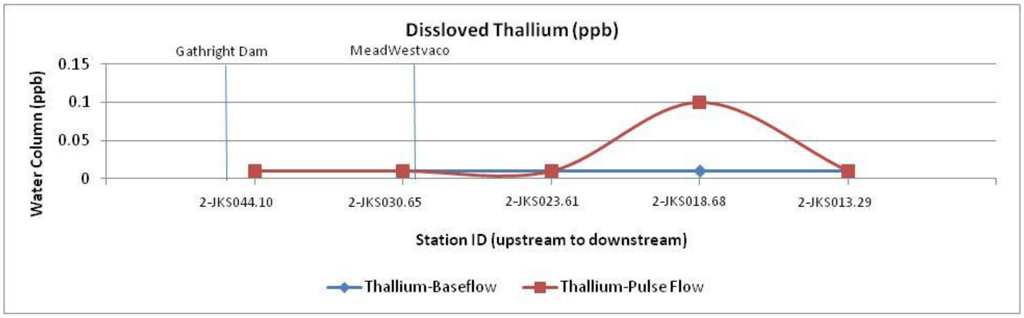


Figure 39. Dissolved Nickel (ug/L).

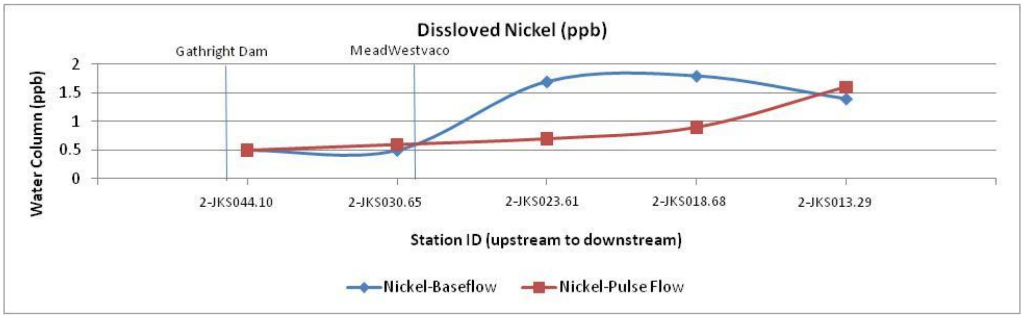


Figure 40. Dissolved Silver (ug/L).

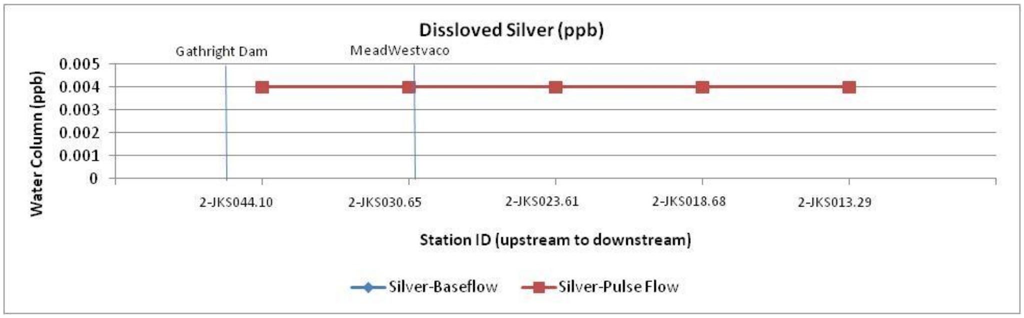


Figure 41. Dissolved Zinc (ug/L).

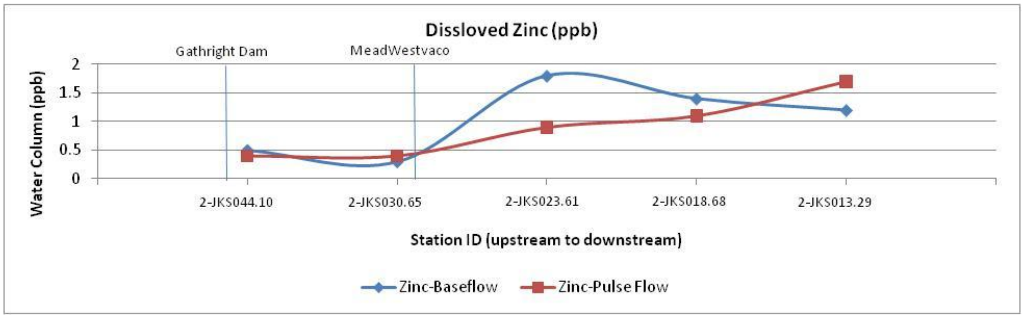


Figure 42. Dissolved Antimony (ug/L).

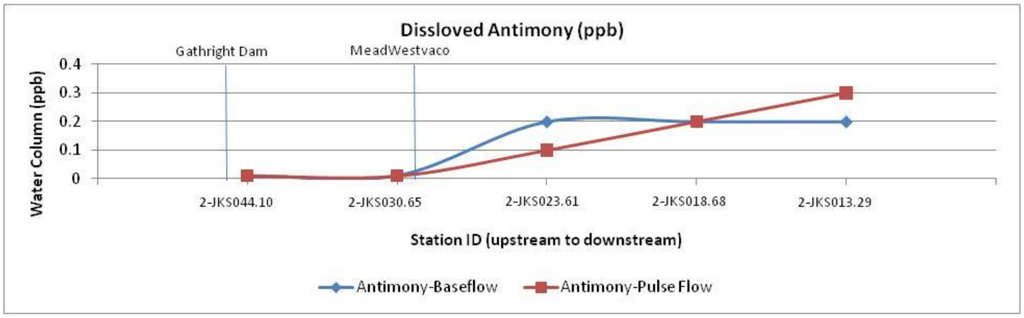


Figure 43. Dissolved Aluminum (ug/L).

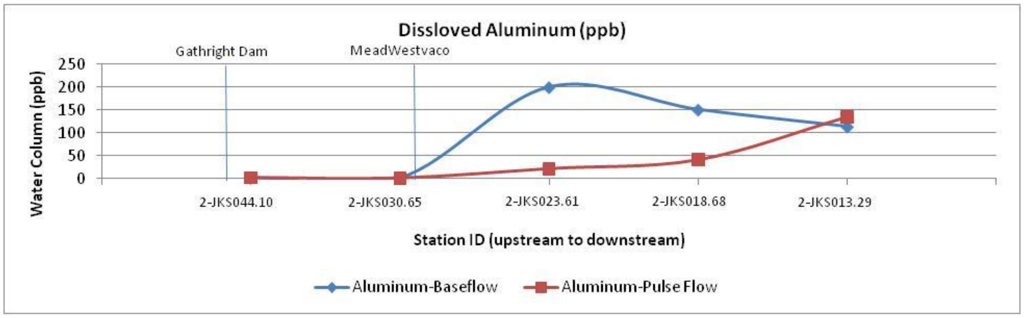


Figure 44. Dissolved Selenium (ug/L).

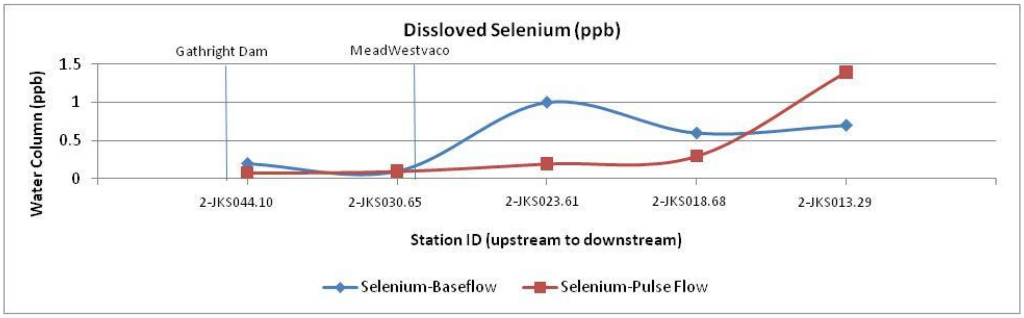


Figure 45. Dissolved Mercury (ng/L).

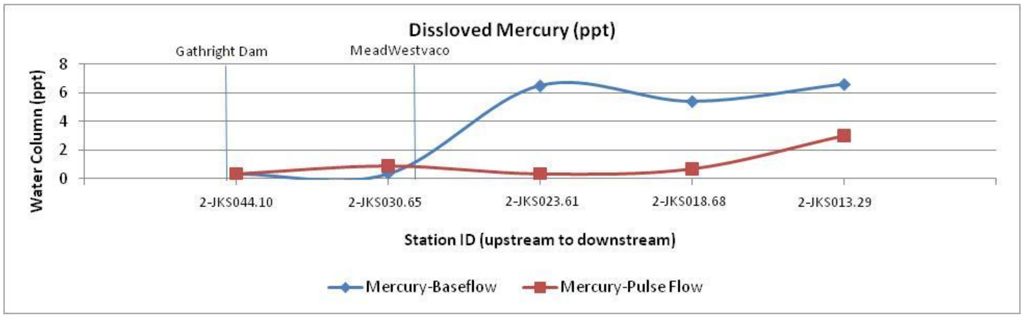
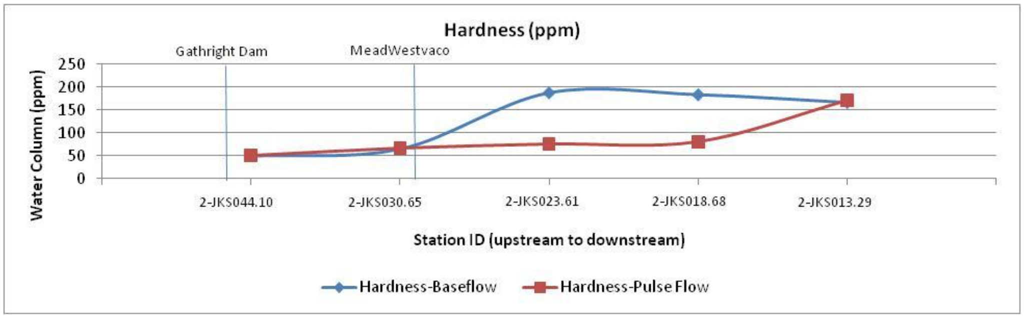


Figure 46. Hardness (mg/L).



Lake Profiles

Figures 47 and 48 present the Lake Moomaw profile data for the month of August. A modest decline in oxygen levels occurs in the epilimnion from the beginning of the August until the end of the month, which is reflective of the natural progression through the summer months. The profile shape is not significantly different the day of the pulse (August 17^{th}, 2010) than the day before or after. However, dissolved oxygen levels appear slightly lower the day after the pulse. Temperature is shown in degrees Celsius and dissolved oxygen is displayed in mg/L in figures 47 and 48.

Figure 47. All Lake Moomaw Profile Week of Pulse (August 16 to August 18).

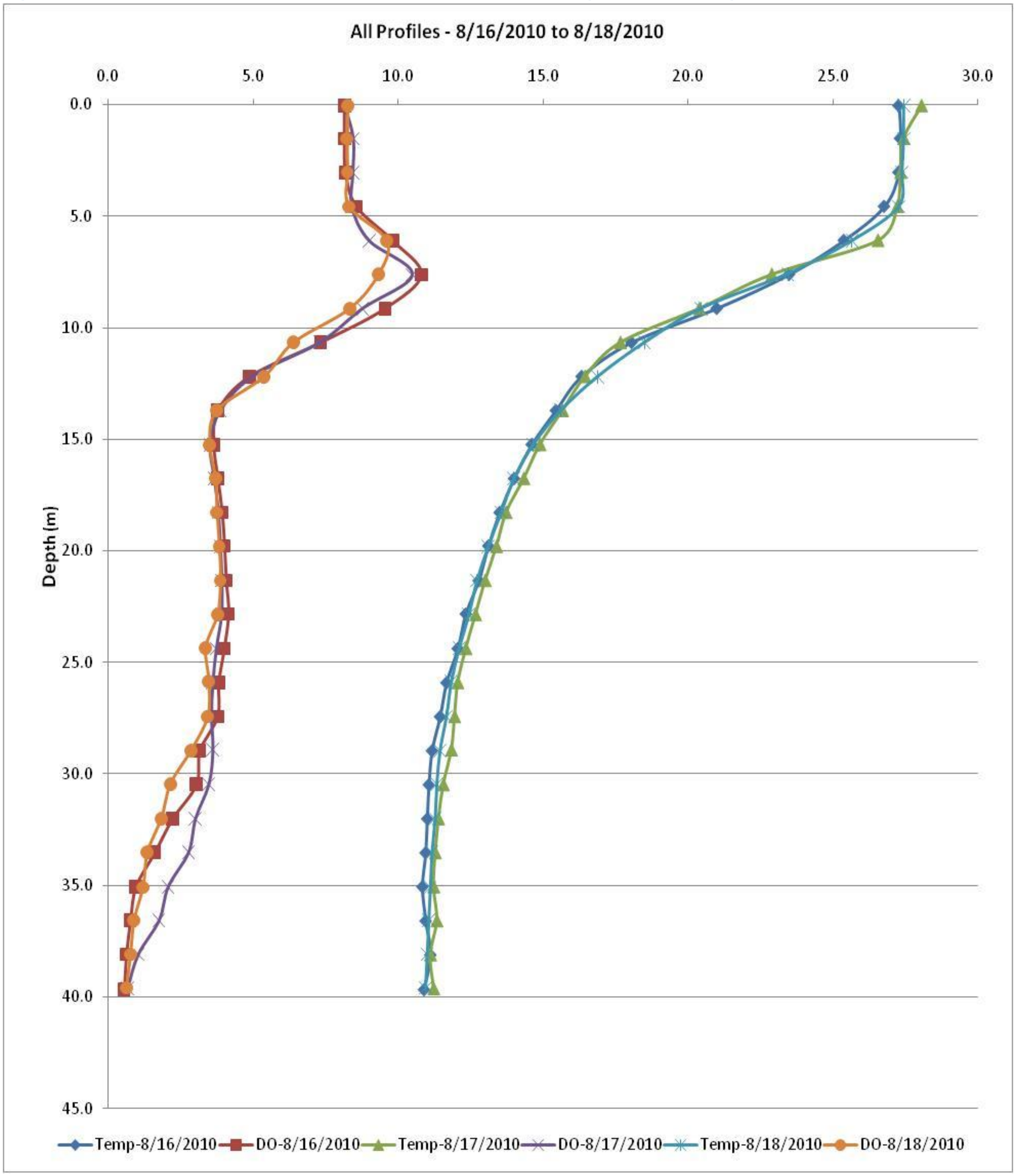
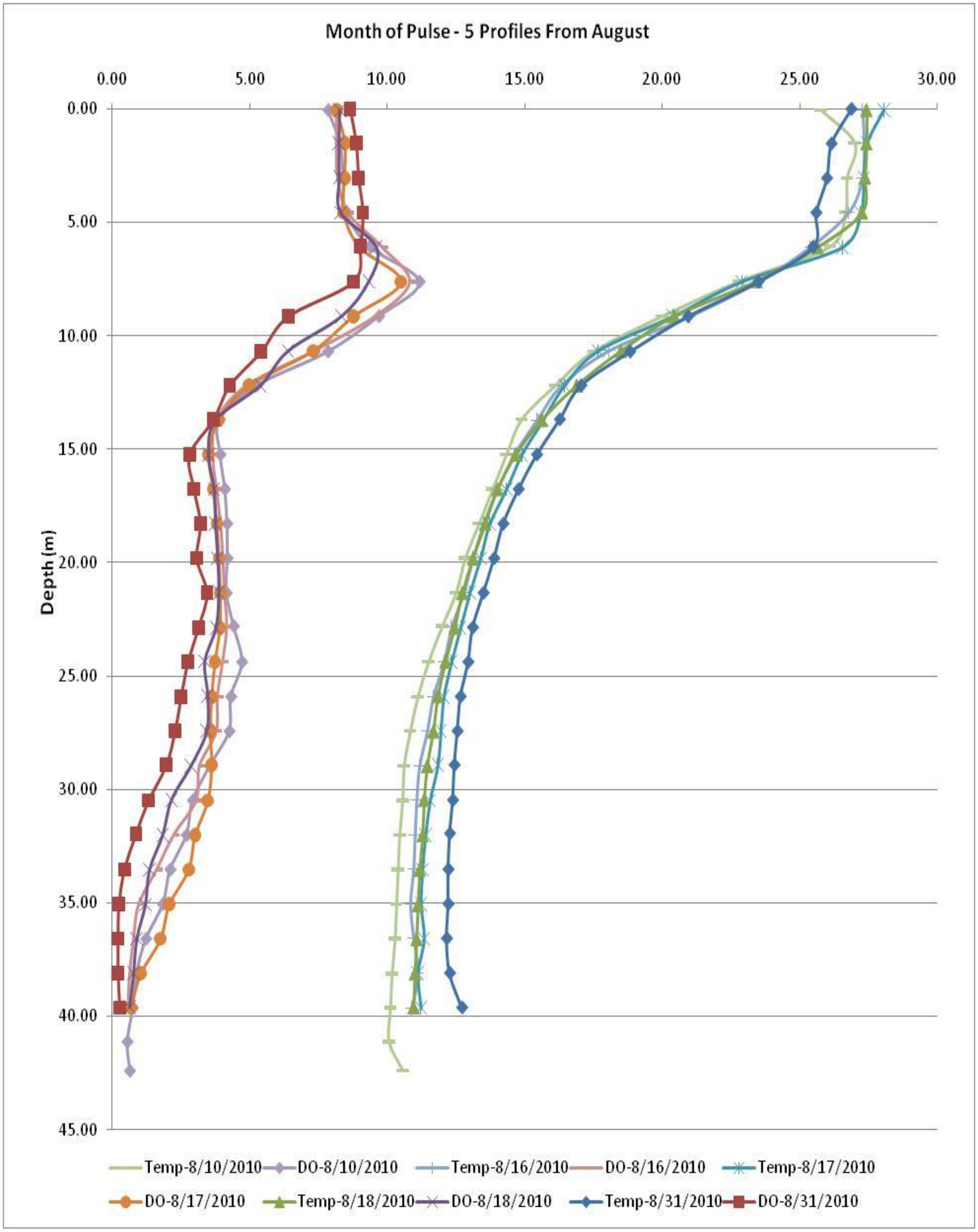


Figure 48. All Lake Moomaw Profile Month of Pulse (August 2010).



Habitat Data Collection

Rapid Bioassessment Protocol Habitat Data

Habitat is defined as the area or environment where an organism or ecological community resides. It encompasses the organism's or community's surroundings, both living and non-living. Fish, aquatic insects and plants require certain types of habitat to thrive, so in-stream and riparian (stream bank) habitat is evaluated to complement a biomonitoring sample. Since different organisms have diverse habitat components, a variety of available habitat types in a stream or river will support a diverse aquatic community. Habitat is scored by evaluating ten habitat parameters and adding them together (total scores range from 0 to 200). Habitat scores lower than 120 tend to represent degraded habitats in Virginia while scores above 150 indicate habitat conditions that are favorable for supporting a healthy aquatic community (EPA 1999). As seen in table 7, total habitat scores reflect favorable habitat conditions in the Jackson River and scores slightly improved after the pulse event. The embeddedness parameter was the sole reason for the slight increase in the habitat scores. Embeddeddness is an important parameter that refers to the extent to which rocks and snags are covered in silt, sand, or biomass. As embeddeddness scores decrease, many forms of aquatic life no longer have suitable habitat in which to live.

Table 7. Rapid Bioassessment Protocol Habitat Data results.

Parameter	Clearwater Park		City Park		Rt. 18 Bridge		Low Moor Cave		Dabney Lancaster	
	Pre-Pulse	Post-Pulse	Pre-Pulse	Post-Pulse	Pre-Pulse	Post-Pulse	Pre-Pulse	Post-Pulse	Pre-Pulse	Post-Pulse
Substrate	19	19	15	15	16	16	19	19	16	16
Embeddedness	17	17	5	7	8	10	10	11	13	13
Velocity	19	19	19	19	19	19	19	19	20	20
Sediment Deposition	19	19	16	16	18	18	18	18	19	19
Flow	20	20	18	18	19	19	20	20	20	20
Channel Alteration	15	15	15	15	15	15	14	14	15	15
Riffle Frequency	19	19	17	17	16	16	19	19	19	19
Bank Stability	18	18	15	15	16	16	16	16	17	17
Bank Veg	16	16	12	12	16	16	18	18	15	15
Riparian Veg	11	11	10	10	7	7	8	8	14	14
TOTAL Habitat	173	173	142	144	150	152	161	162	168	168

Environmental Monitoring and Assessment Protocol (EMAP) Habitat Data

Degradation of available habitat through excessive sedimentation is one of the most prevalent impacts to benthic communities. Excess sediment fills interstitial spaces in the stream substrates used by aquatic organisms for habitat and can potentially smother the organisms themselves. Until recently, tools for rapidly quantifying sedimentation impacts in streams have been inadequate. Methods existed for describing dominant particle size, but it was difficult to differentiate between natural conditions and man-made problems. Virginia has a variety of stream types; many are naturally sand/silt bed streams, so simply measuring the size of the sediment particles cannot differentiate natural and human-influenced sediment load.

VDEQ uses the relative bed stability (RBS) tool for predicting the expected substrate size distribution for streams (Kaufmann 1999). This method incorporates stream channel shape, slope, flow and sediment supply. The method calculates a 'stream power' based on channel measurements to predict the expected sediment size distribution. The ratio of the observed sediment to the expected sediment is a measure of the RBS and reported in base 10 log. A stream with an LRBS of less than -1 is carrying excess sediment while streams above -0.5 have a normal sediment load (Kaufmann 1999 and USEPA 2000).

It should be noted that VDEQ used the boatable collection method for these samples, but the calculation for this method is the same as the published wadeable method. The mean particles size (LSUBDMM), percent fine particles (% Fines), and LRBS are all similar and show a stable river system with the exception of the Route 18 bridge site. The percent fines were much higher at this location with a Log RBS (LRBS) number that indicates more fine particles than would normally be expected. The excess fines may be attributed to the land cover around the sample site or from the large amount of fine particles that were observed below the Covington STP, which discharge right above the Route 18 monitoring station (Figure 1, Table 1). It is important for VDEQ and its stakeholders to understand current habitat and sedimentation conditions to see if the flow modifications will alter future habitat conditions.

Table 8. Relative Bed Stability data (Boatable Method).

Parameter	Clearwater Park	City Park	Rt. 18 Bridge	Dadney Lancaster
% SLOPE	0.17	0.21	0.11	0.2
LSUBDMM	2.24	2.28	1.04	2.46
LRBS	0.09	0.08	-1.15	0.29
% Fines	0.03	0	0.41	0
Reach (meters)	2000	2000	2000	2000

Biological Data

Benthic Algae Data

Benthic Chlorophyll A (Chl A) and Ash Free Dry Mass (AFDM) were collected both low above the Mead Westvaco discharge the day before the pulse (Figures 49 and 50). Below the Mead Westvaco discharge, Chl A and AFDM were significantly higher the day before the pulse, especially at City Park and Route 18 Bridge. The day after the pulse Chl A was 30% lower and AFDM was 20% lower at City Park. However, the results were mixed at Route 18 which has a slight increase in Chl A (3%) and a decrease of 22% in AFDM. Further downstream, at Low Moor Cave and Dabney Lancaster station has increased levels of Chl A and AFDM. However, these increases are not considered significant. VDEQ conducted two additional weeks of follow-up monitoring at City Park and Low Moor Cave.

The first week after the pulse the City Park Chl A and AFDM levels decreased an additional 57% and 33%, respectively. Two weeks later, City Park Chl A levels increased by 433% and AFDM increased by 325%. This sudden increase was more than expected and maybe due to dry weather sewage overflows occurring in the City Park sampling reach. This problem will be corrected by the end of summer 2011, so future pulse event sampling will not include the untreated sewage nutrient loads. Follow-up monitoring at the Low Moor Cave site showed both parameters essentially holding steady. Please refer to Figure 1 and Table 1 for a map and description of these site locations.

Figure 49. Benthic Chlorophyll A before and after the August 2010 Pulse event.

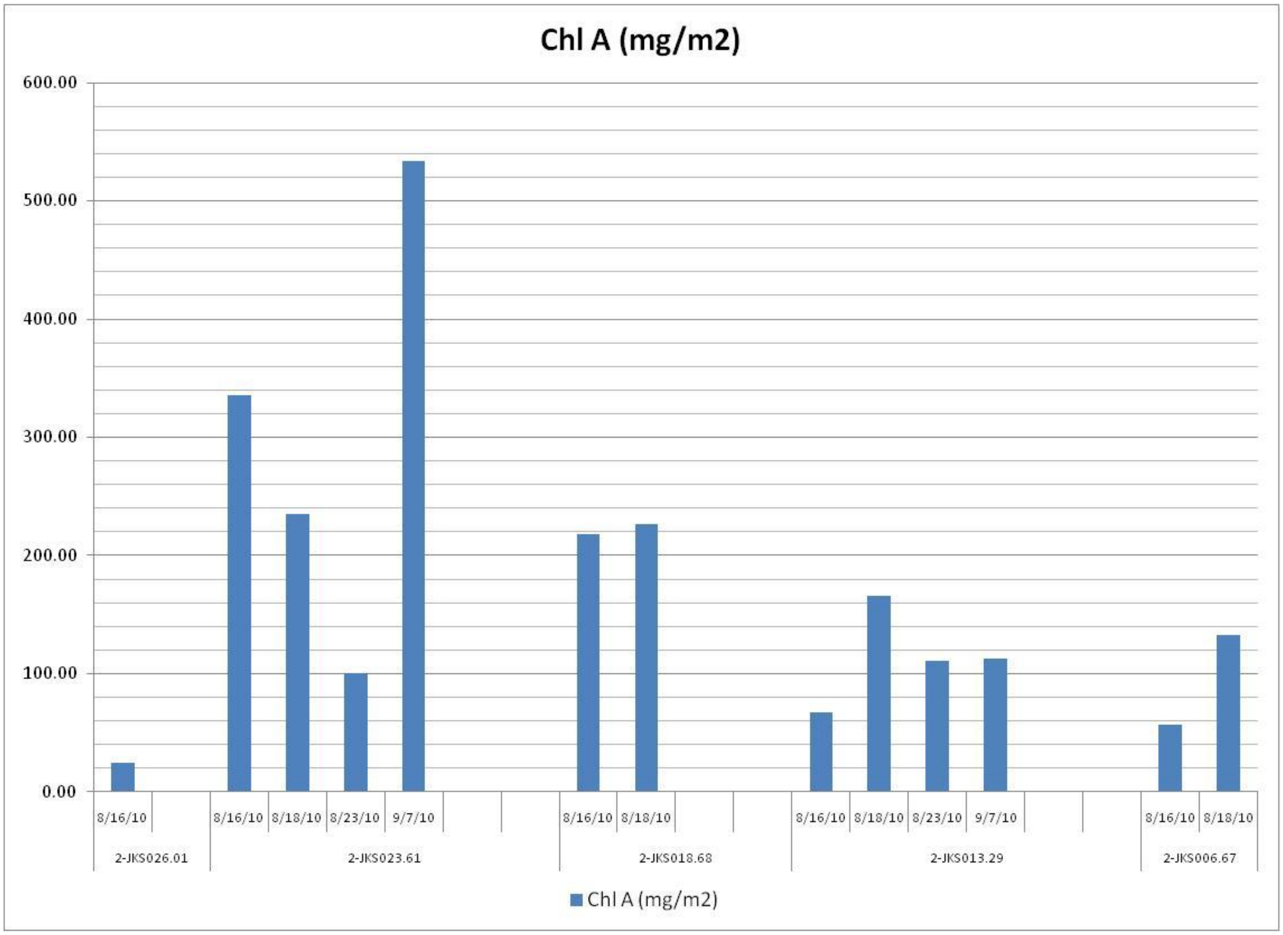
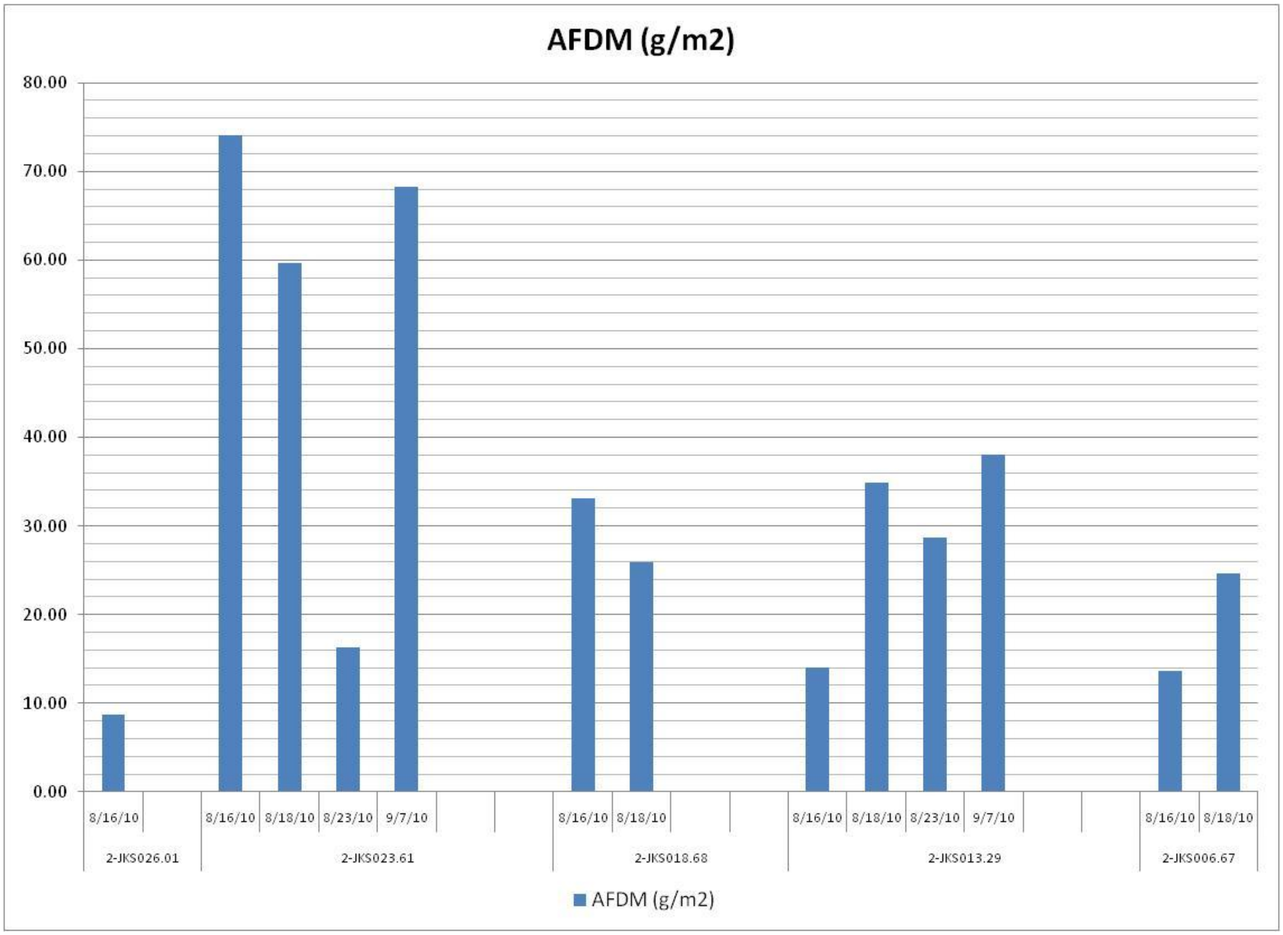


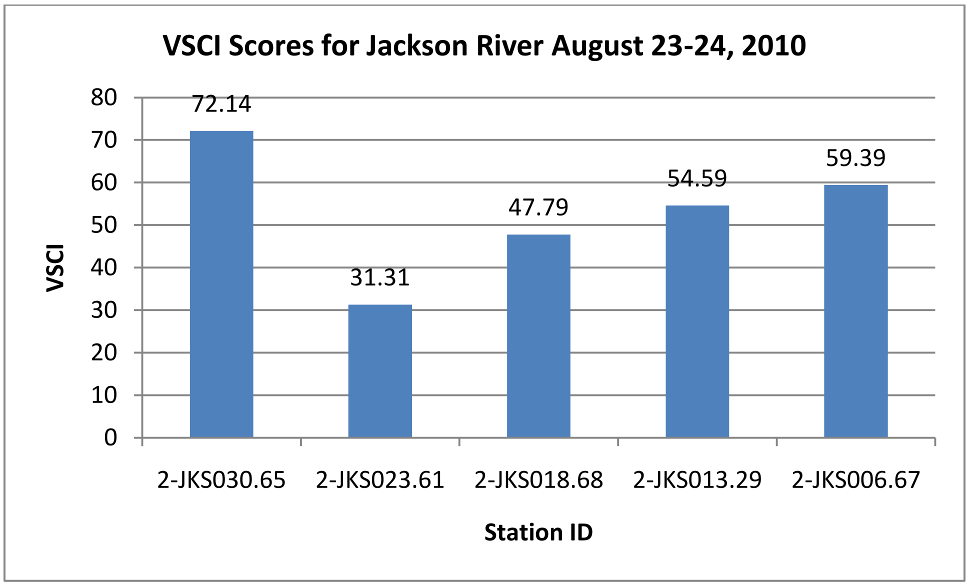
Figure 50. Ash Free Dry Mass before and after the August 2010 Pulse event.



Benthic Macroinvertebrate Data

Benthic macroinvertebrates were collected on August 23rd (2-JKS018.68, 2-JKS023.61) and 24th (2-JKS030.65, 2-JKS013.29, 2-JKS006.67) at five stations on the Jackson River (Figure 1). Benthic macroinvertebrate communities were assessed using Virginia's Stream Condition Index (VSCI), a single-value index comprised of eight core metrics. VSCI scores are above reference condition, VSCI = 60, at Clearwater Park (2-JKS030.65) and then decline at City Park (2-JKS023.61). The benthic community improves gradually downstream of City Park.

Figure 51. Virginia Stream Condition Index scores.



Fish Community Data

VDEQ does not have an official index of biotic integrity to assess aquatic life using fish community. However, the Jackson River fishery is very important and much beloved by many of the Commonwealth's citizens. VDEQ, Virginia Department of Game Inland Fisheries (VDGIF), and the 216 stakeholders recognize this important fishery and collected fish community information to characterize the fish community before any hydrologic modification occurs. A number of commonly used fish community metrics were used to summarize the current health of the fish community and it is believed that the fish community will improve along with the benthic macroinvertebrate community as the TMDL is implemented.

Number fish species (Figure 52), proportion of sculpin (Figure 53), proportion of omnivore species (Figure 54), proportion of species with anomalies (Figure 55), proportion of invertivores (Figure 56), proportion of simple lithophils (Figure 57), proportion of intolerant fish (Figure 58), and proportion of general habitat fish (Figure 59), are the eight fish community metrics reported in this document.

The number of fish species appears normal for the James River basin. The proportion of sculpin species, which tend to be more sensitive to environmental stressors, decreases below Covington. The proportion of omnivore species increases at City Park and Route 18, which corresponds to the excessive benthic algae found at those sites. The proportion of fish with anomalies, such as lesions and eroded fins, increases in Covington and downstream. It should be noted that fish in the upper James River have been experiencing an unknown affliction for the last several years and the anomalies observed may not be directly correlated with environmental stressors. The proportion of invertivores decreases as you go downstream on the Jackson River; these fish species exclusively feed on aquatic insects. Proportion of simple lithophils (rock-gravel) refers to the percent of fish species that need clean substrate to reproduce. Simple lithophils were reduced at City Park and Route 18 probably due to the lack of interstitial spaces in the large cobble due to increased biomass around the rocks. Proportion of Intolerant Fish refers to a subset of fish species that are considered vulnerable to environmental stressors, these fish populations are reduced at City Park, Route 18, and Dabney Lancaster Community College. The proportion of general habitat fish metric refers to species that are able to spawn on various substrates, these fish species increase at City Park and Route 18.

Figure 52. Number of Fish Species collected at each Jackson River sampling site.

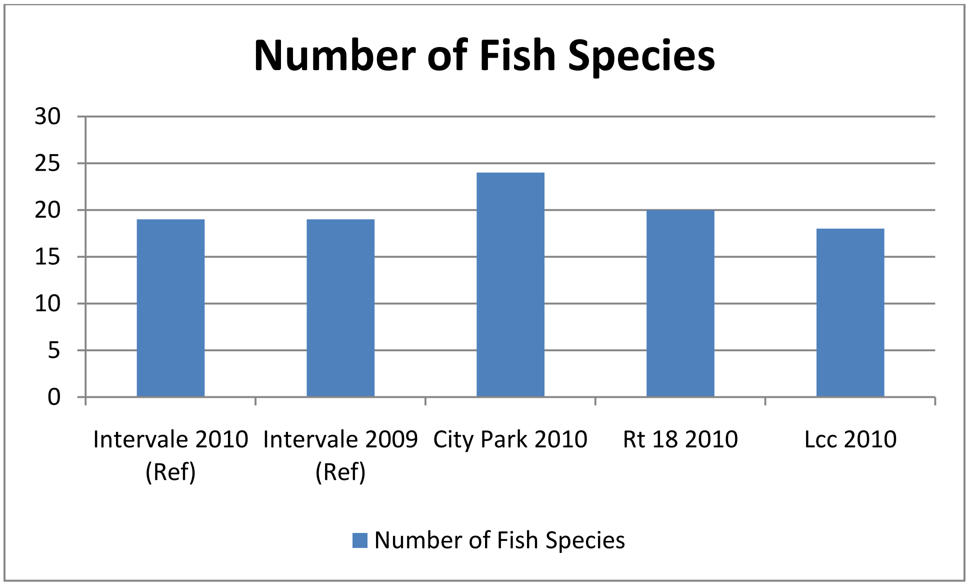


Figure 53. Proportion of sculpin collected at each Jackson River sampling site.

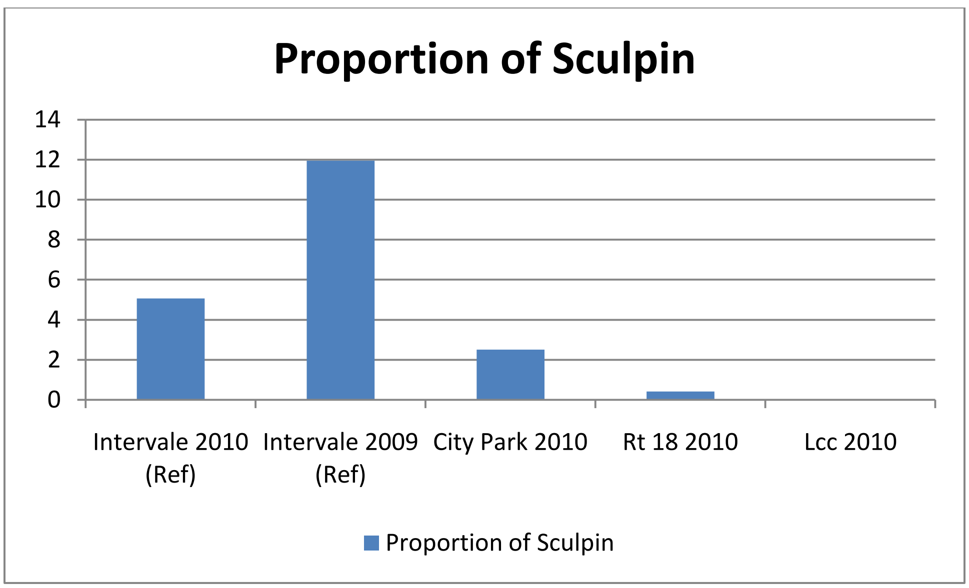


Figure 54. Proportion of omnivores collected at each Jackson River sampling site.

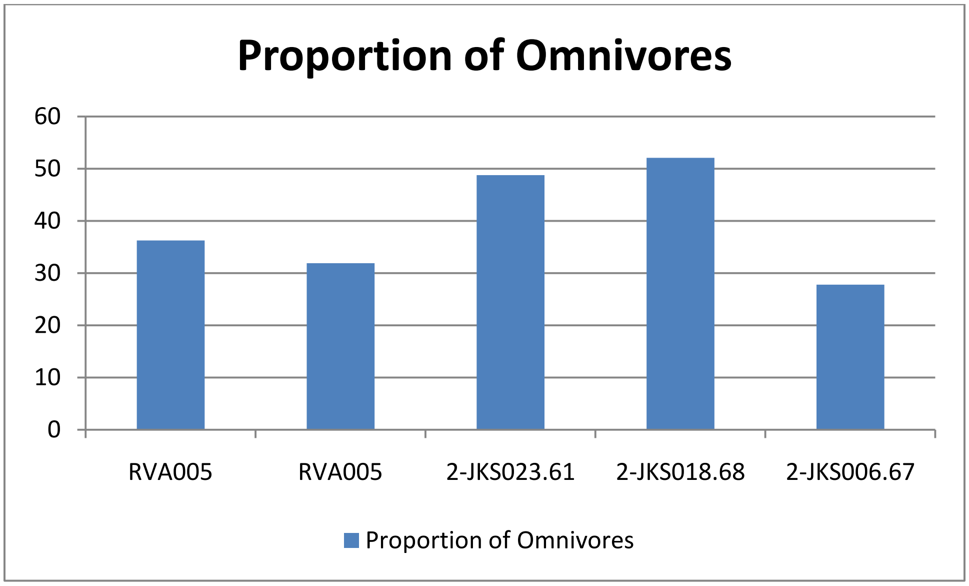


Figure 55. Proportion of fish with anomalies collected at each Jackson River sampling site.

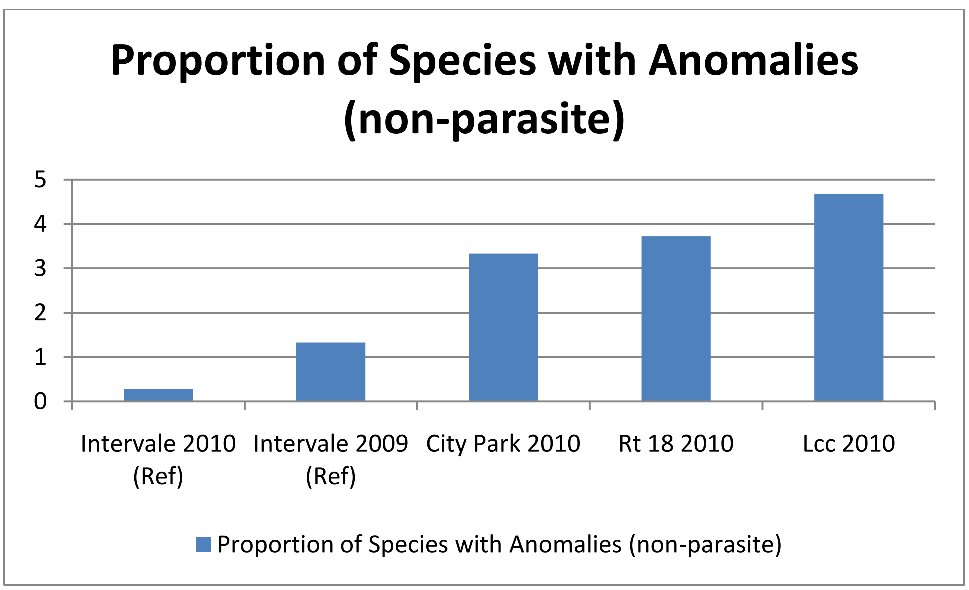


Figure 56. Proportion of invetivores collected at each Jackson River sampling site.

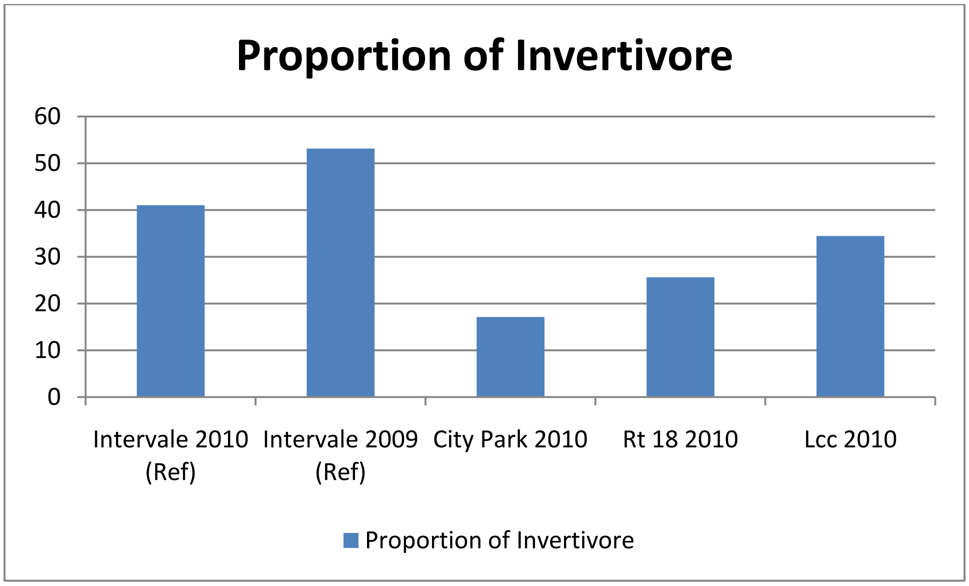


Figure 57. Proportion of simple lithophils collected at each Jackson River sampling site.

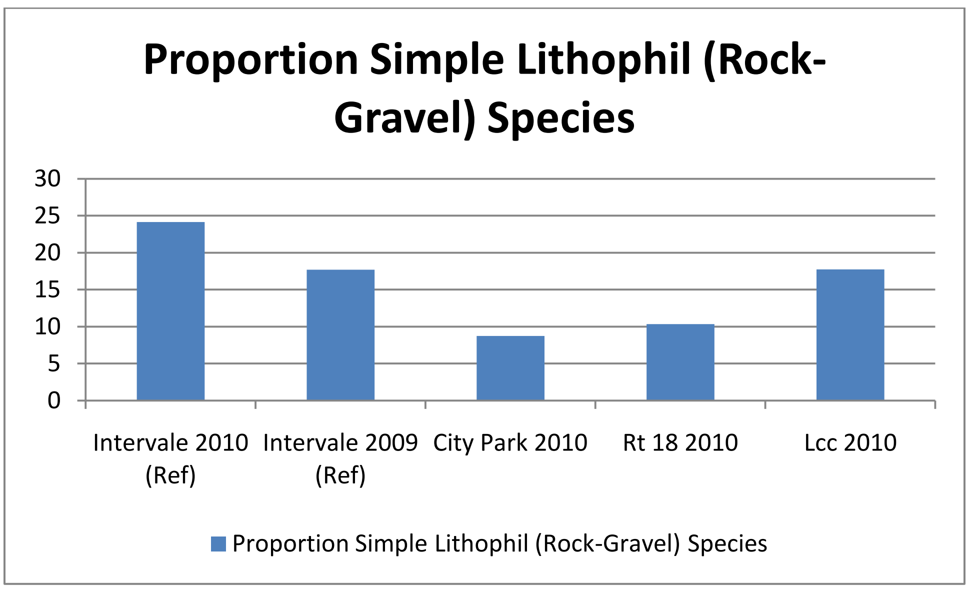


Figure 58. Proportion of intolerant collected at each Jackson River sampling site.

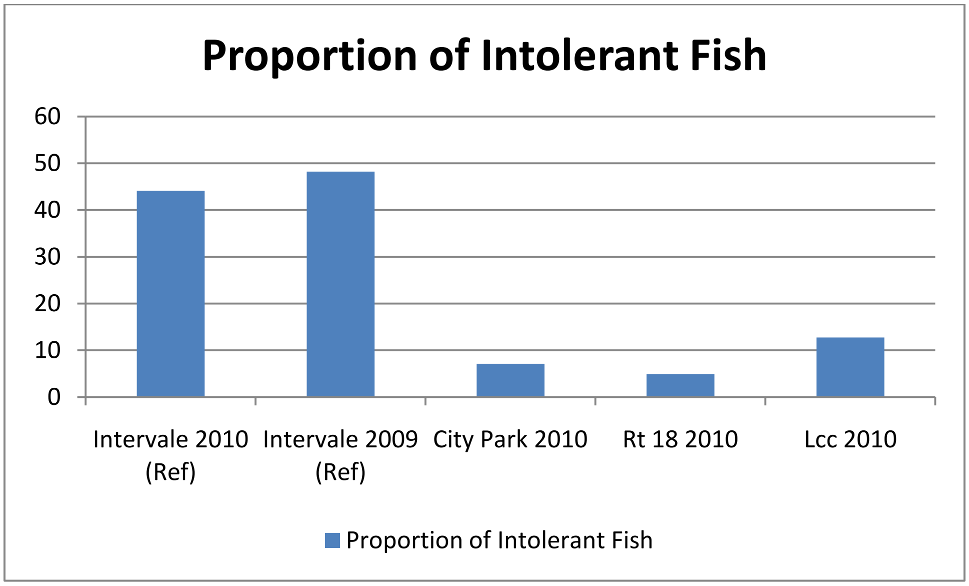
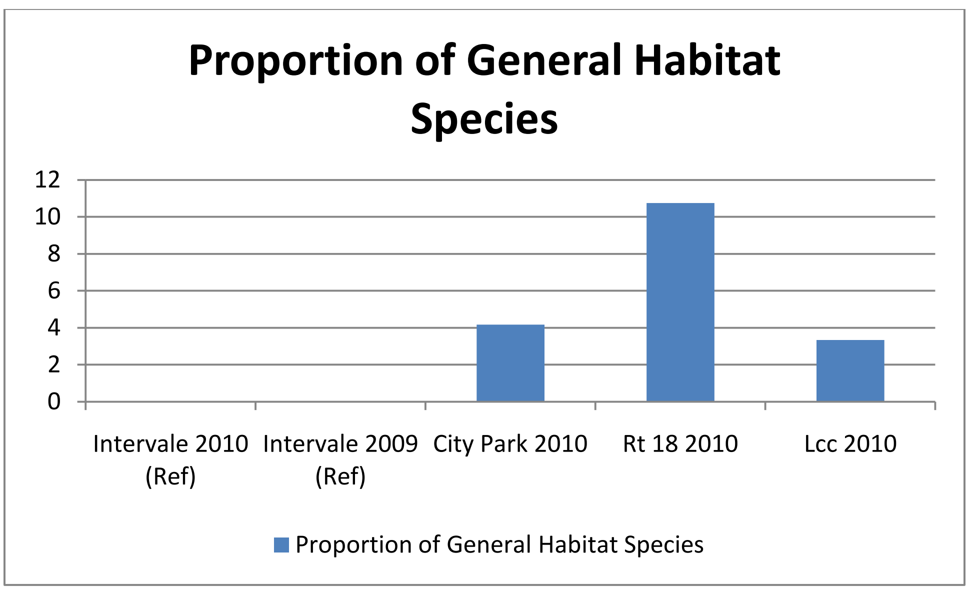


Figure 59. Proportion of general habitat species collected at each Jackson River sampling site.



Conclusions

- Temperature, Dissolved Oxygen, pH, and Specific Conductivity in the Jackson River was not negatively impacted in stream from pulse event. Dissolved oxygen was improved significantly below Covington.
- Thermocline in lake remained intact during summer pulse event
- Metals were low from pulse event and within all water quality standards
- Total suspended solids and turbidity increased significantly during pulse event in the entire reach. VDEQ suspects multiple pulse events over the entire growing season would result in more moderate solids levels (due to lack of buildup from tributaries)
- Habitat in the Jackson River is in optimal conditions with few sedimentation issues. Slight habitat improvements were documented for in-stream embeddedness, an important parameter for improving aquatic life in the Jackson River below Covington.
- Documented current fish and macroinvertebrate community structure to ensure above Covington tailwater maintains high biotic integrity and we can document improved biotic integrity below Covington
- VDEQ will request another pulse test in late September to capture different conditions in Lake Moomaw, and will request increasing flow to 3500 cfs from Gathright Dam to observe 3000 cfs in Covington.

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